MECHANICAL ENGINEERING

· JULY 1949 ·

Departments

Keeping Btu's IN LINE at Tomkins Cove

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The installation includes:

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Bailey Three-element Feed Water Control
Bailey Steam Temperature Control
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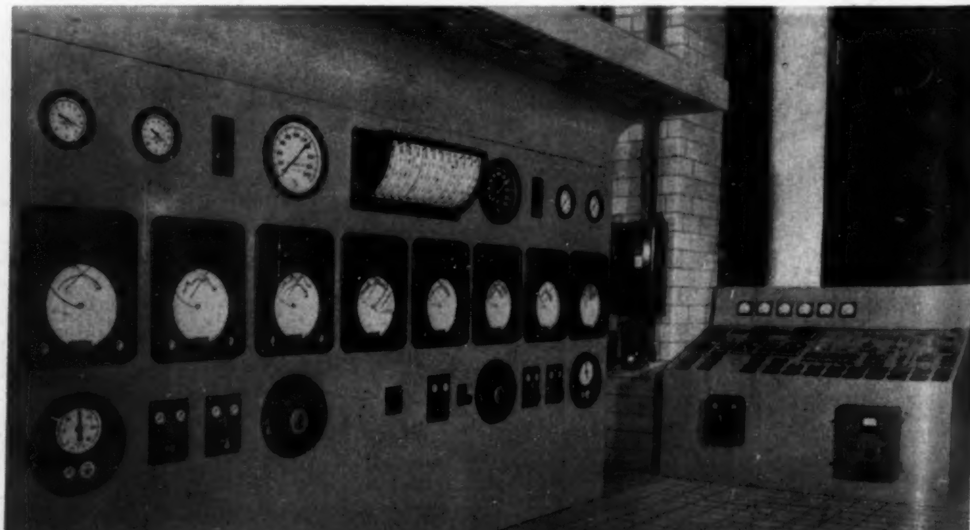

Bailey Boiler Control Panels for 200,000 lb per hour capacity, 880 psi, 900° F pulverized coal-fired boiler at the Hudson Steam Plant of Rockland Light and Power Company, Tomkins Cove, New York. All Boiler Controls are co-ordinated to insure efficient handling of the heat energy released in combustion.

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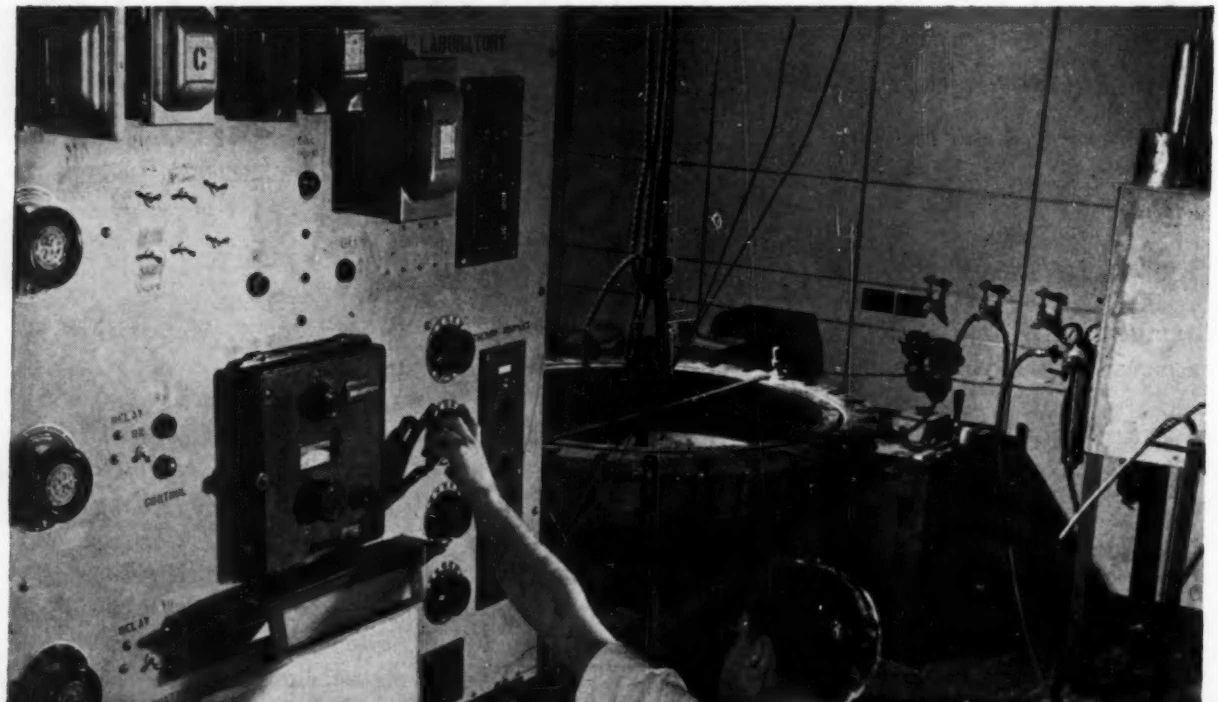

Courtesy Johns-Manville Corporation

Thermal Conductivity Laboratory

(Control panel of equipment used in measurement of thermal conductivity of insulations. Precise measurement of thermal conductivity is essential in the development of insulating brick, insulating and refractory cements, pipe coverings, and other types of insulations. At the right is another testing device.)

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MECHANICAL ENGINEERING

JULY
1949

GEORGE A. STETSON, *Editor*

The Common Man

IN the minds of American school children at the beginning of the twentieth century, and indeed before and since that period, the word revolution had an almost sacred significance. For them it meant the War for Independence, the great conflict between the American colonies and the mother country, which marked the political origin of the United States of America. If today the word in general usage arouses less noble sentiments in our minds, it is because we value our political heritage so highly that we view with apprehension, distrust, and violent objection the efforts of minorities to overthrow our government or radically to change the form of it by subtle though peaceful means.

Revolution was characteristic of the seventeenth century. Side by side with the American Revolution the western world witnessed the French Revolution. Men who found themes and inspiration for their literary works in the great upheaval of political philosophy that was symptomatic of that era, were known as the Revolutionary Poets. The extensive changes in living standards that were introduced by the use of steam power and the machine gave rise to the Industrial Revolution. Darwin and his contemporaries, who were inquiring into the fundamentals of the biological sciences, had not popularized the term evolution, that slower and more orderly process of change of which revolutions mark the more dramatic epochs in human affairs. Bloodless or bloody as these events may have been, they mark steps in a procession of changes that originated in the minds of men, and their counterparts are troubling us today.

With the breakdown of authority—traditional, imposed, revealed—because of the work of philosophers and scientists, the concept of the relationship of man to his fellow man and to the state took on a new significance in the western world, in which the dignity of man held a key position. The inspiring words, "liberty, equality, fraternity," awakened men to the promise of a new era, vitalized them into action, gave them courage to face the consequences of those actions, dulled the sting of temporary defeat, sustained their faith in times of adversity, and made them heroic in sacrifice. It was the age of the common man whose destiny lay in his own hands, who exchanged the burden of imposed authority for the more difficult one of responsible citizenship in a free society, a position in which he has no one to blame for his misfortunes and no one to look to to maintain life, liberty, and the pursuit of happiness but himself.

Although the nineteenth and twentieth centuries glorified the common man in the western world, they also laid burdens of self-preservation and self-discipline on him, accentuated the differences between his status and that of men in other parts of the world, and provided the opportunities for conflict between him and those who still adhere to authoritarian philosophies and submerge the dignity and importance of the individual in the service of the state. It is no longer possible to rely upon geographical or political isolation to safeguard a Utopia from debasement and destruction. And even if the integrity and security of the common man could be safeguarded by such means, ideas would not be excluded from men's minds because of them. The common man needs more than to be let alone to pursue his aimless way in a fool's paradise of constitutional rights and privileges that outsiders will not respect and that insiders will usurp when disunity, waning faith, and false doctrines weaken the eternal vigilance that is the price of liberty. He needs to develop some uncommon qualities.

The Uncommon Man

VIEWING the dangers that beset the common man and the society in which he lives, persons who are passionately devoted to his interests and welfare, to the preservation of his rights, and to the advancement of his forms of government, have recently called attention to the need for the uncommon man. A dispatch to *The New York Times* of last November states that Herbert Hoover, in a message to educators and business leaders, called upon American colleges to develop "uncommon men and women who can undertake leadership in the nation."

"It is a curious fact," Mr. Hoover is reported to have said, "that when we get sick we want an uncommon doctor. If we have a construction job, we want an uncommon engineer. When we get into war, we dreadfully want an uncommon admiral and an uncommon general. Only when we get into politics are we content with the common man. . . . . . Our full hope of recovery in the moral and spiritual world is a wealth of uncommon men and women among our people. It is our educational institutions that must promote and train them. . . . . We must have this uncommon sort of men and women, if we are to have leadership in government, in science, in education, in the professions, and in the home."

In a dispatch to the same newspaper under date of April 10, 1949, Sir Norman Angell is quoted as saying: "The greatest service we can do the common man today

is to abolish him and make all men uncommon." Sir Norman is reported to have pleaded for a "moral sense," described as "a sense of the fallibility of our judgment," and to have deplored a general failure "to emphasize the truth that only by intellectual discipline can we do our duty in the political and social fields."

"When we come to a conclusion," he asserted, "we stand outside the matter with which we deal; but when we are concerned to judge political and social affairs, we, our tempers, our passions, our desires, our fanaticisms, are the raw material of judgment. If it is to be dependable in the very least degree, then it will be by virtue of a moral quality upon which, I suggest, our moralists have perhaps placed altogether too little emphasis."

In a world preoccupied with concern for the common man and the "things" that are too frequently cited as a measure of his standard of living and his sense of satisfaction, it is gratifying to know that two prominent persons recognize that the common man's need is for uncommon qualities of intelligence and leadership, and that our judgments of political and social matters must be imbued with a moral quality.

Value Judgments

IT would be vastly to the credit of the engineering profession if its members were entitled to public recognition as common men who possess uncommon qualities. This is a high ideal, but it is the least that should be expected of professional men. Toward the realization of this ideal the engineering societies and the engineering colleges have been striving ever since engineers first developed a professional consciousness and a sense of obligation and responsibility to their fellow men.

Particularly since the first World War have programs to this end been purposeful, and accomplishments encouraging. The numerous highly specialized courses of thirty and more years ago, were reconstituted, as a result of studies made by SPEE, into curriculums based largely upon the physical sciences and their engineering applications. More recently the technological group of courses has been paralleled by another representing the socioeconomic stem of studies. Breadth and depth have been afforded engineering students by these means; and in addition to the all-important factor of technical competence in some line of engineering practice there has been stimulated an interest in and a desire to participate in the nonengineering phases of human affairs. Nor have the teachers of engineering and administrators of engineering colleges been forced to carry on these developments unaided. Engineering societies have helped materially through their own programs in these areas; and collectively, in the Engineers' Council for Professional Development, they have attacked with enthusiasm and with considerable success such tasks as guidance and counseling of precollege students, the accrediting of engineering curriculums, the training of engineering graduates to become fully professional men, and the recognition of professional status by means of the license and election to full membership. As a result of these endeavors, the engineering profession has grown in stature and quality at a time when public need and public confidence were great.

There remains, as Robert E. Doherty pointed out recently, a need for the development of value judgments in engineering education, if the engineering profession is to continue its growth and if it is to exercise the full potentialities for leadership that lie ahead of it. President Doherty stated his thesis in the following manner:

"Under the American system, professional men largely set the fundamental pattern of national life. The character of that pattern depends not alone upon their technical ability, nor yet upon whatever ability they may have in dealing with human and social situations; it also depends—depends critically—upon their attitudes, upon the way they look at things. These attitudes have some of their principal roots in value judgments; and these value judgments in turn depend critically—or perhaps I should say *can* depend critically—upon education. Therefore any program for the development of an electrical engineer, or of any other professional man for that matter, must recognize this fact, or else fall far short of what I believe is now required for an enduring America. In other words, the ends toward which abilities are used are just as important in determining the outcome in national life and individual life as the abilities themselves, and those ends are determined when values are adopted. Hence recognition of the critical role of value judgments, and therefore of the importance of cultivating intelligent procedure in arriving at them, are educational 'musts' of the first order."

In the development of his thesis President Doherty cited three stages in the achievement of intellectual competence and maturity: In the first stage, one learns merely facts; in the second, one selects and pulls together related facts and information; in the third, one acquires "the disciplined ability to analyze and the creative ability to devise means to an end." The task with which President Doherty is primarily concerned is "how to help the student achieve the second and third stages in connection with values. How can we help him to discriminate among values and to arrive at intelligent judgments? How can we best guide him to an effort to relate these value judgments to each other? How can we help him to learn how to use them as a basis for deciding what to do in practical situations?"

Discussion of how engineering students may be trained to make value judgments is beyond the scope of this comment, the purpose of which is to emphasize the importance of this element of professional education that President Doherty has called to our attention. No sane man will question the desirability of attempting to develop value judgments, regardless of the methods used. He would hope that students might be trained to develop skill in the use of this useful intellectual approach to all problems and thereby enrich the engineering profession and our national life, and he can believe that the ability to form correct value judgments will make uncommon out of common men.

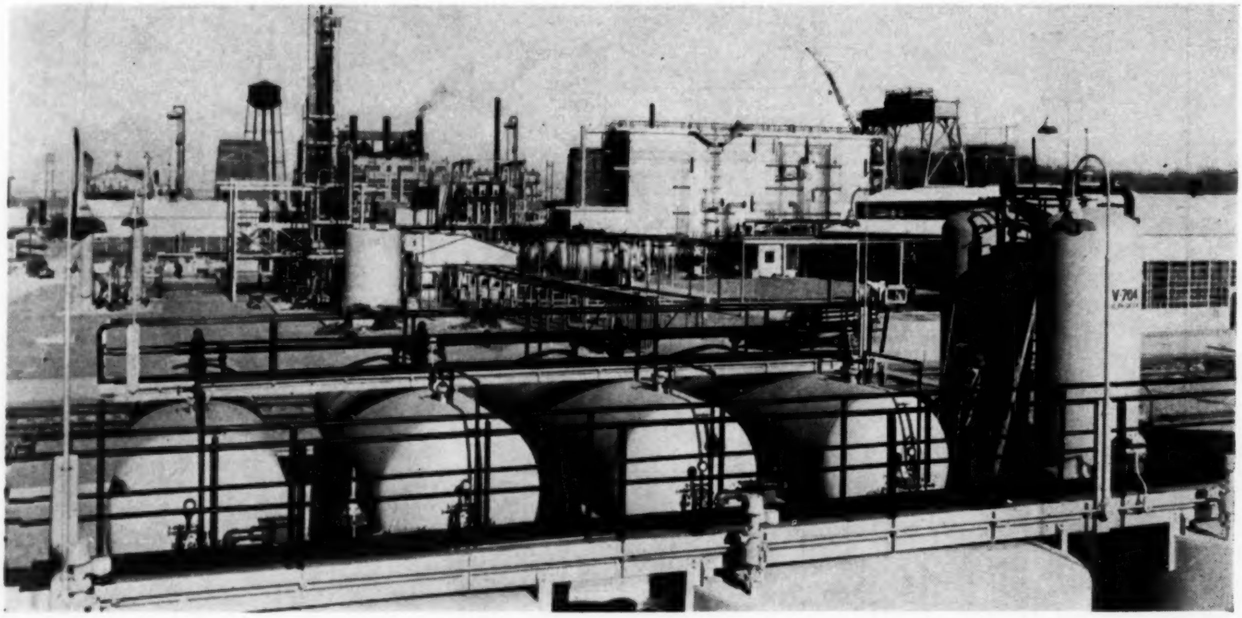


FIG. 1 COAL-HYDROGENATION DEMONSTRATION PLANT OF THE BUREAU OF MINES AT LOUISIANA, MO.

COAL HYDROGENATION

Summary of Process and Brief Description of Special Equipment Used in Demonstration Plant at Louisiana, Missouri[1]

By J. A. MARKOVITS[2]

OFFICE OF SYNTHETIC LIQUID FUELS, LOUISIANA, MO.

COAL has been hydrogenated in Germany on a rather extensive scale for the past 20 years, but the process is new to the United States. In the Coal Hydrogenation Demonstration Plant at Louisiana, Mo., 10,000 psi operating pressures are combined with temperatures up to 1000 F, and the materials to be processed at these conditions range from gases to mixtures of viscous liquids containing high percentages of abrasive solid particles. These service conditions presented unusual engineering problems, and the use of special equipment. Few items were commercially available for the chosen process. Where there was a choice between importing equipment from Germany or building it here, the latter was done. It was the hard way, but it was considered desirable in order to acquire design "know-how" and to give American manufacturers an idea of the basic requirements for the design of future commercial-size plants. Within the limitations of the project the equipment was chosen and sized so that the results of operations would be representative of those expected in modern full-scale hydrogenation plants.

The demonstration plant was designed and built by the Bechtel Corporation, San Francisco, Calif., in co-operation with the Bureau of Mines, Fig. 1.

[1] Published by permission of the Director, Bureau of Mines, U. S. Department of the Interior, Washington, D. C.

[2] Assistant Chief, Coal-to-Oil Demonstration Branch.

For presentation at the Petroleum Division Conference, Oklahoma City, Okla., October 2–5, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

BRIEF DESCRIPTION OF PROCESS

The primary chemical difference between coal and crude petroleum is that there is approximately twice as much hydrogen in the latter. Thus for the hydrogenation of coal to finished gasoline, hydrogen amounting to approximately 9 per cent of the weight of the moisture and ash-free coal has to be combined with the coal to form the products.

The plant was designed to operate at the 700 atm pressure level, in two major steps. Liquid-phase hydrogenation accomplishes liquefaction of coal, and vapor-phase hydrogenation converts the liquefied coal to gasoline and by-products. The output of the plant will be 200 to 300 bbl of gasoline per day, depending upon the coal and catalyst used. Fig. 2 is a flow sheet, and Fig. 3 is a view of the plant looking at the converter stalls.

The raw coal is first crushed to minus $^3/_4$-in. size, then pulverized to minus 60-mesh in a ball mill and dried to 1 or 2 per cent moisture content by a gas-fired recirculating drier. The pulverized coal is mixed with a small quantity of catalyst, such as iron oxide or tin oxalate and with heavy oil, previously obtained from the liquid-phase process, into a paste containing approximately 47 per cent solids.

The viscous paste is injected into the paste preheater by steam-driven plunger pumps, working at 10,000 psi. The preheater is of modified radiant type, in which the high-pressure tubing is protected by a superheated-steam jacket. A small amount of hydrogen is injected into the paste before it enters

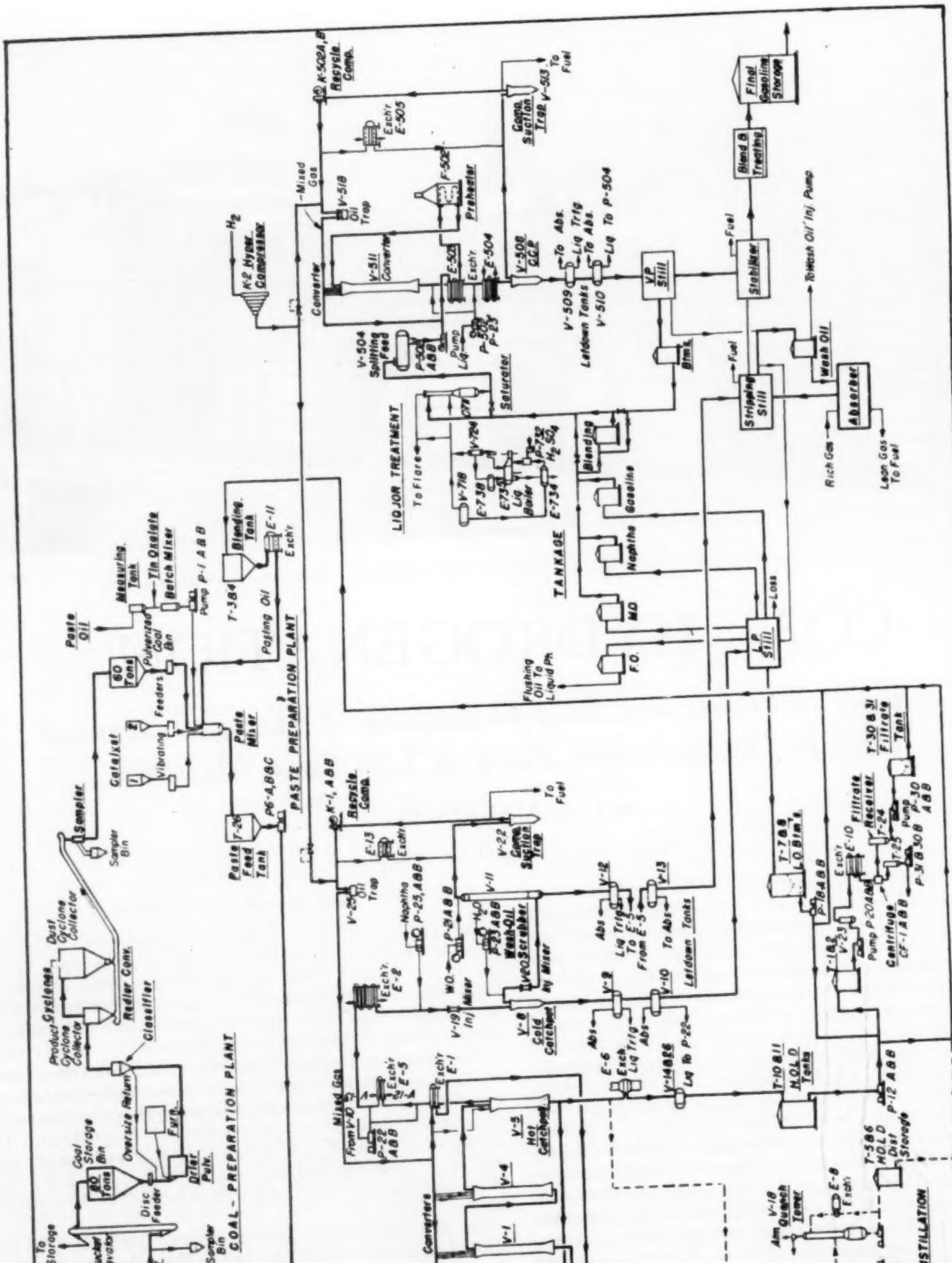


FIG. 2 COAL-HYDROGENATION PROCESS FLOW SHEET

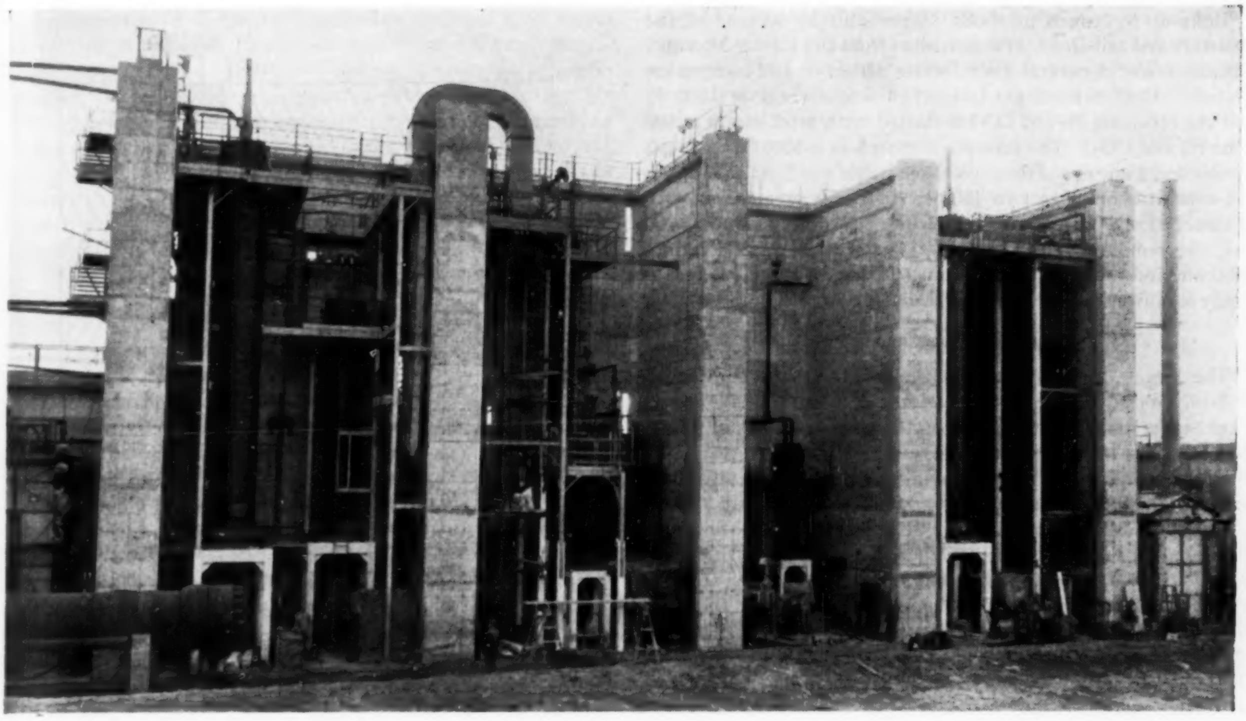


FIG. 3 STALLS OF HEAVY REINFORCED CONCRETE ENCLOSE ON THREE SIDES THE GIANT CHROME-STEEL CONVERTER VESSELS IN WHICH COAL IS TRANSFORMED INTO OIL

the preheater, to reduce the viscosity, and it is heated in the first section to about 570 F. At this stage, additional hot hydrogen and recycle heavy oil are added to jump the temperature to the 640 F level, circumventing coal-swelling difficulties that would occur around 600 F. After passing through the remainder of the preheater, the mixture leaves at about 815 F and passes into the first of two converters. For 95 per cent conversion of the coal to liquid and gaseous products, the residence time is approximately 1 hr. The reaction is highly exothermic, and to maintain the reaction temperature at 930 F, cooling hydrogen is added to the converters in controlled amounts at different points.

After the second converter, the reacted products enter the "hot catchpot" where the hydrogen and light ends separate from the solid-containing heavy-oil fraction. "Letting down" the heavy oil to near atmospheric pressure is the next step. This is extremely difficult, because the hot liquid contains large volumes of absorbed gases and up to 30 per cent of abrasive solids. The heavy oil is freed from ash, catalyst, and unreacted coal by centrifuging or by flash distillation with 1100 F superheated steam. The oil fraction constitutes the bulk of the pasting oil used in the process.

The gases and vapors leaving the top of the hot catchpot are cooled in a heat-exchanger system, and the condensed liquid and vapor are separated in the "cold catchpot." The gas from the cold catchpot, containing about 70 per cent hydrogen, is mixed with water at full operating pressure to remove NH_3, H_2S, and water-soluble salts, and is washed with oil to separate the light hydrocarbons. After this purification the hydrogen stream is recycled through the system with fresh make-up hydrogen. The liquid products from the cold catchpot and from the wash-oil scrubber go through let-down systems, where the pressure is reduced in two steps, first to 25 and then to 7 atm, and are then charged to the distillation unit.

The bottoms from the liquid-phase distillation unit join the pasting-oil stream. Gasoline, naphtha, and middle-oil cuts are separated to establish weight relations and to prepare, by blending, a feed stock of uniform composition for the vapor-phase hydrogenation. This stock is combined with a nearly equal amount of vapor-phase recycle middle oil and saturated with H_2S or with sulphur for the vapor-phase hydrogenation step. The addition of some form of sulphur is necessary to preserve the activity of the vapor-phase catalyst.

The vapor-phase injection pumps, working at 10,000 psi, feed the charge, to which hydrogen is added, through a feed-product exchanger and a radiant-type vapor-phase preheater. The stream leaves the preheater completely vaporized. This vapor enters a single converter containing six fixed catalyst beds. The catalyst is fuller's earth, treated with 7.5 per cent hydrofluoric acid and impregnated with compounds of zinc, molybdenum, chromium, and sulphur. The catalyst is very rugged and at 700 atm performs the triple duty of the former German saturation, splitting, and dehydrogenation operations. The reaction is quite sensitive to temperature variations, and recirculated cooling hydrogen is added at every tray to keep the temperature between the 912 and 930 F operating limits. After the reaction is balanced, the feed-product exchanger provides most of the heat necessary, and the duty of the preheater becomes negligible.

The products then pass through a cooler and a cold catchpot, where the condensed oil and hydrogen are separated. The hydrogen is returned to the circulating compressor, and the liquid passes through a two-step let-down system to the vapor-phase distillation unit. The bottoms are recirculated to the vapor-phase hydrogenation system; the overhead is stabilized to a 10-lb RVP gasoline, washed with caustic and water, and sent to final storage. Tail gases pass through an absorber before being used for fuel. Ammonia, CO_2, and H_2S liquors are treated with sulphuric acid before going to the sewer, and the recovered H_2S is utilized to saturate the vapor-phase charge.

Make-up hydrogen of about 11 per cent by weight of the moisture and ash-free coal is furnished from the former Missouri Ordnance Works natural-gas reformer, scrubber, and compressor system. Here natural gas is cracked with steam at 1700 F, and the resulting H_2 and CO are shifted with more steam at 800 F to H_2 and CO_2. The mixture is stored in a 300,000-cu-ft gas holder and compressed through three stages of a 7-stage 210,000-cfh-capacity compressor to 450 psi, at which pressure the CO_2 is scrubbed out with water. After the 7th stage, around 11,000 psi, the remaining CO is removed by catalytic reaction into methane and water. The resulting 97 per cent pure hydrogen is ready for injection into the gas-circulating system.

HIGH-PRESSURE VESSELS

The largest forged vessels in the plant are the converters. A 3-in. asbestos-cement layer is placed between the 900 F reaction basket and the shell, holding the shell temperature below 500 F. This internal insulation permits the full utilization of the low-temperature properties of steel, reduces temperature stresses, and minimizes hydrogen attack.

The liquid-phase converters, V-1 and V-4, are alloy-steel forgings, 32 in. ID, $49^1/_2$ in. OD, and 39 ft long. The heads are 57-in-diam, $21^1/_2$-in-thick, flat steel forgings, and are provided with openings for the coal paste, hydrogen, and the products. There are no openings in the converter shell. The shell steel is 3 per cent chrome alloy with 0.65 per cent nickel, 0.30 per cent molybdenum, and 0.25 per cent carbon, having an ultimate tensile strength of 100,000 psi, and an elastic limit of 55,000 psi. Past experience has shown that a minimum of 3 per cent chromium is desirable to resist the penetration of hydrogen, and the corrosive effect of H_2S at 500 F and 10,000 psi.

The API-ASME Code stipulates that when pressure vessels have a wall thickness greater than 10 per cent of the inside diameter, the Lamé formula, based on the maximum principal stress theory, shall be used in determining the required wall dimensions. The maximum allowable stress was taken at 25,000 psi, which is less than one half of the elastic limit, and using this formula, the required wall thickness became $8^3/_4$ in.

The converter heads are subjected to more severe temperature conditions than the shell, and a higher-chrome alloy steel was selected. The head-thickness calculation was based on Roark's formula for flat bolted cover plates, and with safety factors resulted in a $21^1/_2$-in-thick forging. The head steel is 4 to 6 per cent chrome with 1 to 1.25 per cent nickel, and 0.40 to 0.80 per cent molybdenum. The head studs, of which there are 12 in each head on a $45^1/_2$-in-diam bolt circle, are $5^3/_4$ in. diam of SAE-4340, with an ultimate tensile strength of 120,000 psi, and an elastic limit of 90,000 psi. The stud nuts are of SAE-4140, with an ultimate tensile strength of 100,000 psi, and an elastic limit of 70,000 psi. The shell weighs 80 tons, each head adds $7^1/_2$ tons, and the assembled converter, with internals, weighs about 105 tons.

The asbestos-cement lining for the converter shell is mixed in the proportion of 1:1:1 by volume of granulated asbestos, quick-setting Portland cement, and water. The mixture is poured and tamped in sections in the annular space between the shell and the basket. The basket is stainless steel, ASTM-A240-347, and has a reaction space of about 130 cu ft. This steel was chosen for its good hydrogen and corrosive gas resistance at temperatures up to 1000 F. The basket is $25^1/_2$ in. ID, with $^1/_4$-in-thick wall, perforated with $^5/_{16}$-in-diameter holes on 3-in. centers for pressure equalization.

The self-sealing gasket of SAE-1020 steel is of triangular cross section. About 0.002-in. copper plating was added to the polished gasket faces, which improves the seal considerably by eliminating the galling of contact surfaces during fluctuation

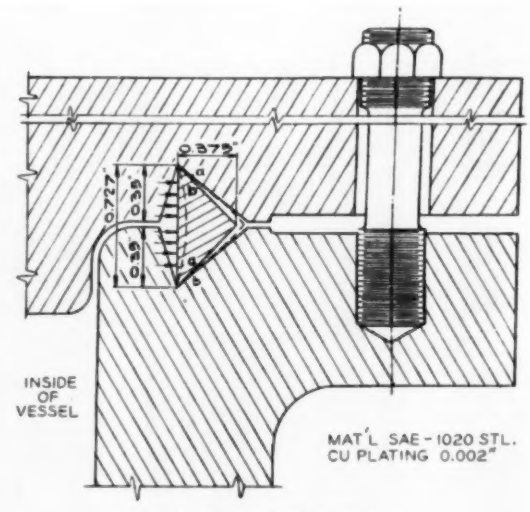


FIG. 4 DELTA GASKET DETAIL

in pressure. The initial seal is created on opposite tips of the gasket by the bolting force. The gasket becomes deformed after internal pressure is applied, as shown by dotted lines in Fig. 4. Sealing actually takes place along faces marked *a* and *b* in the cross section. The soft-iron gasket is of small cross section, and the internal pressure forces the entire gasket to expand in diameter when the pressure forces the bolted head away from the shell.

Temperature measurements within the converters are taken through centrally located 40-ft-long, 2-in-OD and $^7/_8$-in-ID, seamless-steel pyrometer tubes. Each tube, held in place by several steel spiders, has a closed bottom and is designed to withstand an external pressure of 10,300 psi at 1000 F. Inside of the tube is a $^1/_8$-in. schedule-40 pipe of ASTM-A276-304 stainless steel, to which 6 thermocouple elements are attached on 6-ft centers. The measurements at the various levels are transmitted from these elements to recording instruments located in the control house.

The vapor-phase converter is similar to the liquid-phase converters; the main difference is in the internal arrangement.

The catalyst space in the basket is subdivided into six compartments by perforated grids covered by a wire screen to support the 10-mm-diam × 10-mm-long pelleted catalyst. The grids also provide uniform distribution for the cooling hydrogen gas supplied to the bottom of each grid by separate $^3/_8$-in. lines introduced through the top head.

The general construction and dimensions of the hot catchpot are similar to the liquid-phase converters, except that the shell is shorter. The normal level of the liquid in the pot is about 5 ft above the bottom. To prevent settling of solids and coking at the bottom of the pot, a $^1/_2$-in-size perforated schedule-40 pipe, bent to a $23^1/_2$-in-diam ring is provided a few inches above the bottom for agitating and cooling the liquid with hydrogen.

Measuring and regulating the liquid level in the hot catchpot is a very important but troublesome operating function, and, in an attempt to make it foolproof, various methods were provided and are expected to work simultaneously. The primary method consists of introducing hydrogen into the liquid and the vapor space of the hot catchpot and measuring the difference in pressure between the two lines as an indication of the height of the liquid. An automatic level control and an independent manual-control arrangement are working on this principle. It should be noted that the total pressure is around 10,000 psi, whereas the head variation is but a few feet.

Another method of controlling the hot catchpot level works on the principle that liquids or vapors of different specific gravity, which come between a radium source and a Geiger Mueller detector, have a different degree of gamma-ray absorption which is not influenced by temperature, pressure, or chemical composition of the liquid in the vessel. The changing rate of gamma rays striking the detector causes variations in the electrical impulses. These impulses are amplified and electrically transmitted to an electronic recording controller. The detector utilizes the penetrating power of gamma rays from an iridium-platinum needle containing a small amount of radium salt mounted on the pyrometer tube to a gamma-ray detector on the outside of the vessel.

The temperature of the hot catchpot contents is also observed by pyrometer readings, but the pyrometer tube in this case extends from the bottom up.

Fig. 5 shows the arrangement and dimensions of the cold catchpots V-8 and V-508. The arrangement of the product inlet line will provide efficient separation of gases from liquids without foaming. At the elevation of the impinging stream the vessel is lined with an interchangeable carbon-steel wear cylinder. The shell-steel analysis is 2.50 to 3.25 per cent nickel, 0.75 per cent chromium, and 0.30 to 0.40 per cent molybdenum, the heads are carbon steel, and head studs, nuts, and gaskets are the same as for the converters and the hot catchpot.

Since the normal operating temperatures are below 150 F, the cold catchpots are neither insulated nor lined on the inside.

Compressor suction traps V-22 and V-513, and wash-oil scrubber V-11 are similar to the cold catchpots, work under similar pressure-temperature conditions, and are made of the same materials. All high-pressure vessels described in the foregoing are of forged construction. However, during the initial stages of plant design, consideration was given to layer vessels and to the spirally wound vessels (Wickelofen) still in the industrial development stage in Germany. The carbon-steel-plate layer vessels proved to be too heavy and expensive, while the spirally wound vessels were not available from American manufacturers.

All high-pressure vessels are located within a heavy-walled reinforced-concrete structure 193 ft long, 28 ft wide, and 58 ft high, which is open on the top and to the rear. To minimize the danger of possible fires or explosions, the structure is divided into 6 stalls by 14-in. concrete walls. A 130-ton gantry crane with a 70-ft lift on a 365-ft craneway straddles the structure and facilitates handling of the heavy equipment.

PREHEATERS

The design of the liquid-phase paste preheater F-1, is quite original. European paste preheaters were all of the convection type, in which tubes are not exposed to radiation, and the temperature of the combustion gases is regulated by flue-gas recirculation. The possibility of dangerous overheating is remote; but to provide the necessary surface, fins were added outside the tubes. The welding of fins is very difficult, and American manufacturers hesitated to bid on a convection-type heater for the demonstration plant. They advocated the simpler oil-refining-type radiant heater, with low heat densities corresponding to the high viscosity of the paste.

Comparing the two methods, it was found that the permissible over-all heat-transfer rate is approximately the same in both cases. This is governed by the film coefficient of the paste, which depends primarily on the viscosity. Due to temperature changes, the viscosity of coal pastes varies within extremely wide ranges. The approximate behavior of coal paste, based on German information, is illustrated in Fig. 6. With higher temperatures the viscosity drops and the film coefficient increases to a point where the vaporization of the pasting oil and the swelling of the coal are beginning to show their effects. From here on the paste tends to dry, the coal gels, and the film coefficient drops very rapidly. Above a certain temperature, dependent on the composition of the coal and the coal-to-oil ratio in the paste, liquefaction will increase heat-transfer rates with gradually decreasing viscosities. From this it was evident that different stages of the preheating process have to be performed in separate sections of the preheater, each under carefully controlled optimum temperature conditions.

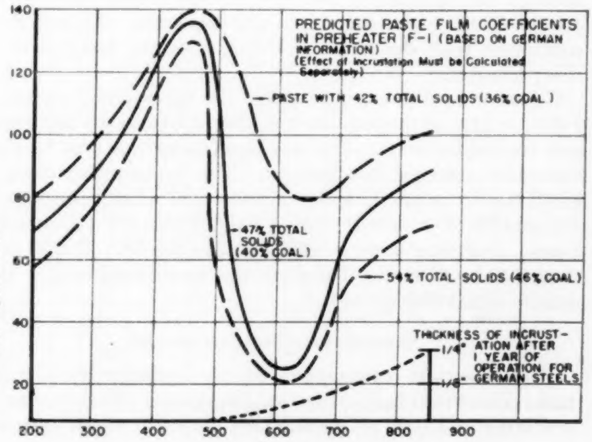


FIG. 6 PREHEATER HEAT-TRANSFER CURVE

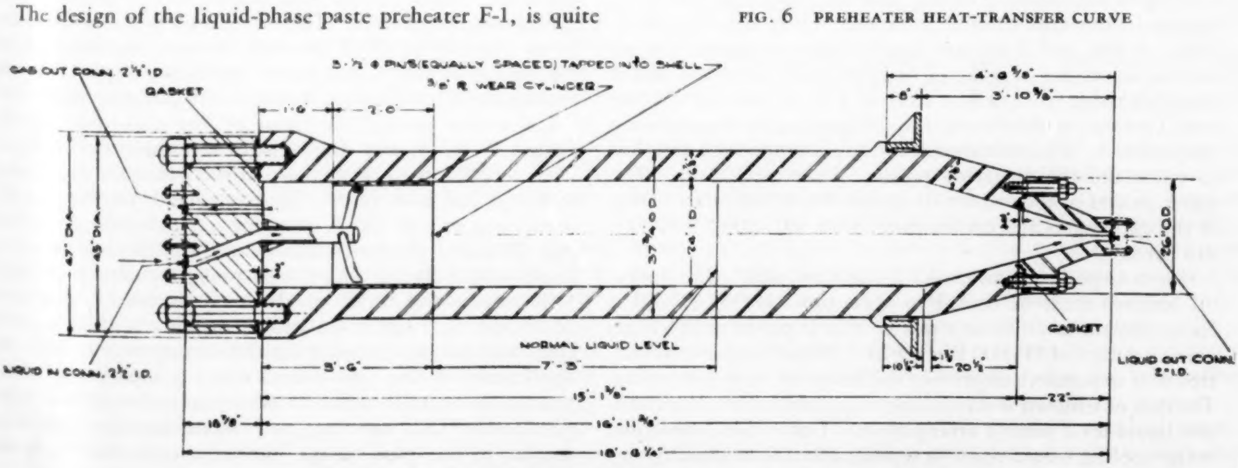


FIG. 5 COLD CATCHPOT AND COMPRESSOR SUCTION TRAP ASSEMBLY

After accepting the radiant-type preheater principle, it was decided that very low heat densities will be used; and, for additional protection against overheating of the high-pressure preheater tubes, a thin layer of highly turbulent superheated-steam blanket was provided, by jacketing the tubes with 4 to 6 chrome-molybdenum pipe.

The heat density was selected on the basis of German laboratory tests and safe commercial data. The governing critical temperature is the tube-metal temperature at the paste outlet, and this was kept below 1000 F for safety. Fig 7 is a heat-transfer diagram showing temperature distribution at this critical point. It may be noted that the uniformity of the annular space between the two tubes is secured with a helical metal rib of 24 in. pitch with a resultant spiral steam motion.

Calculations indicate that the over-all heat-transfer rate of the last cell is 17.9 Btu/sq ft/deg F/hr, whereas the paste-film coefficient is 19.85. It is evident that the heat-transfer loss through the two tubes and the steam jacket amounts to only 1.95 Btu or 11 per cent, and the heat-transfer rate is governed overwhelmingly by the paste film. In a similar calculation made for a convection-type preheater, where the ratio of the inside tube-wall surface to the finned outside surface was 1:20, the over-all heat-transfer rate was 17.15 Btu with the same paste coefficient.

Each of the four preheater cells is separately fired by gas with two vertically arranged burners. The jacketed hairpin tubes are vertical on 15-in. centers located along the side walls of the cells.

Inside the heavy-walled inner tube the paste flows in series through the coils of the four cells. Superheated steam at 400 psi and 750 F enters the jacket near the paste inlet and flows concurrent with the paste. Table 1 gives the design data for this preheater.

Contrary to European practice, the vapor-phase preheater, F-502, is also of the radiant type, but the tubes are horizontal and are not jacketed. The single-cell furnace is fired by three vertically arranged gas burners. The vapor-phase charging stock is split and flows in two symmetrical streams through the $2^1/_2$-in-OD × $1^1/_4$-in-ID tubing of ASTM-A271-316 specifications. Preheater duty is 1,890,000 Btu per hr. The 30 tubes have 378 sq ft surface based on the outside diameter. Heat density is 5000 Btu per sq ft.

HEAT EXCHANGERS AND COOLERS

High reaction temperatures of the hydrogenation process make economical heat utilization important. Only exchangers operating at 10,000 psi pressure are discussed where extremely high heat-transfer rates may be realized in the gas phase. The exchangers are indicated on the flow diagram, Fig. 2, and are located in the high-pressure stall area. E-1, E-2, E-5, E-13, E-503, E-504, and E-505 are double-tube-type exchangers or coolers, consisting of jacketed hairpin coils. Tube and jacket materials range from carbon steel to 8 to 10 per cent chrome with 1 per cent molybdenum alloys, depending on the operating temperature. Wall thicknesses of the exchangers are designed to withstand the operating pressure differentials only. The water jackets of the coolers are standard iron pipe size. Duty of the exchangers and coolers range from 102,000 to 9,350,000 Btu per hr.

Hot catchpot bottoms cooler E-6 is air-cooled. The heavy-oil letdown must be cooled to approximately 375 F, and it leaves the hot catchpot at a rate of 3821 lb per hr at 765 F, requiring a duty of 715,000 Btu per hr. Proper temperature control is of importance to prevent the heavy oil from solidifying. The rate of letdown is fluctuating on account of the hot catchpot liquid-level control arrangement. Under these conditions water-cooling would result in steam formation or overchilling, therefore a forced-draft air cooler was selected for the service. Hot catchpot bottoms cooler E-6 has eight 30-ft-long, 1-in-size Croloy 9M hairpin coils connected for series flow. The cooling air stream passes downward at 58 fps through a 64-in. × 10-in. rectangular duct which encloses the coil. The air is supplied by a 10-hp motor-driven fan at 90 F and leaves at 134 F.

HYDROGEN MAKE-UP AND RECIRCULATION

Hydrogen is used in the process for four distinct purposes:

1 For the hydrogenation of the coal paste and vapor-phase charge. This is the make-up H_2 produced in the H_2-cracking furnaces.

2 To promote the flow of the feed stock through the paste preheater and the liquid-phase converters.

3 To absorb part of the reaction heat and provide temperature control for the converters.

4 To maintain the necessary 75 per cent hydrogen partial pressure in the converters.

To perform these functions an approximate 1:5 make-up to recycle hydrogen ratio is required. There are four recycle compressors, two for the liquid and two for the vapor phase. They are manifolded so that each can serve either phase. While the capacity of each compressor is ample to recirculate the required hydrogen for either the liquid or vapor-phase system, the continuity of supply is so important that it is intended to operate two compressors for each system at reduced rates.

The recirculators are single-stage double-acting compressors with $3^3/_4$-in. bore and $6^3/_4$-in. stroke. Belt-driven at 150 rpm, they are capable of recirculating 400,000 cfh of hydrogen at a stall pressure of 10,300 psig. Two are 150-hp induction-motor-driven at 600 rpm, while the other two have 150-hp, 4000-rpm impulse-steam-turbine drives, with gear reductions to 600 rpm before the belt drive. A by-pass is provided from the compressor discharge to the suction line, with a differential-pressure valve maintaining the differential at a maximum of 750 psi.

Important auxiliaries are the low-pressure nitrogen system for blanketing the coal and paste-preparation equipment, the high-pressure nitrogen for purging the high-pressure equipment, and the high-pressure flushing-oil system which provides a continuous supply of oil for freeing all lines and equipment of solidifying heavy oil and settling solids.

PUMPS

In addition to conventional pumps found in modern refinery practice, a few particular pump applications merit special mention here. Coal-paste transfer pumps P-6A, -B, and -C are of the two-stage "Moyno" type with helical steel rotors and double helical cast-iron stators. They circulate a paste of 1285 centipoises viscosity at 210 F between the paste storage tank and the suction of the high-pressure injection pumps. Pump capacities are 26 gpm, and the drivers are $7^1/_2$-hp gear motors.

The severe service conditions of the coal-paste injection pumps, P-7A, -B, and -C, places them in the critical category. Their function is to inject the coal paste into the liquid-phase preheater and converters. The paste has a viscosity of 4750 centipoises at the 200 F pumping temperature, and 10,300 psig discharge pressure. The pumps are 250-lb steam-driven double-acting duplex forged-steel plunger pumps, working at 50-lb suction and 10,300 psi discharge pressure. With 24-in. × $2^3/_4$-in. bore and 18-in. stroke, capacity is 25 gpm at 14.6 rpm, and the developed hydraulic horsepower is 150. The application of this time-proved direct pumping method is a promising deviation from the oil-driven hydraulic pumps used previously. Oil, naphtha, and water injection pumps are similar to the paste-charge pumps, except that the service conditions are not quite so severe.

TABLE 1 DESIGN DATA OF PASTE PREHEATER

	Normal	Maximum
Furnace number:—F 1		
Service: liquid-phase paste preheater		
Heat duty, Btu per hr:	Normal	Maximum
Paste	3112000	3890000
Gas	255000	319000
Total	3367000	4209000
Performance data:		
Quantity input, lb per hr	Normal	Maximum
Coal paste (at 250 F)	12596	15720
Heavy-oil let-down (at 775 F)	2000	2500
Hot paste gas (at 700 F)	1660	2075
Total	16256	20295
Steam into jacket (400 psig—700 F)		550
Inlet pressure, psig		10000
Maximum working pressure, psig		10300
Pressure drop, steam, psig		200–220

	Heater Sections			
	No. 1	No. 2	No. 3	No. 4
Heat input, Btu per hr:				
Paste	1970000	728000	662000	530000
Gas	319000			
Total	2289000	728000	662000	530000
Temperatures, deg F:				
Paste inlet, max	250	636	701	760
Paste outlet, max	572	701	760	815
Steam inlet	700	943	968	981
Steam outlet	943	968	981	977
Paste tube, wall, max	885	949	964	963
Steam tube wall, max	999	988	999	993
"K"—paste film—Btu/hr/sq ft/deg F	43	16.7	17.8	19.8
Surface area, inside, sq ft	194	194	194	194
Heat density, inside, Btu/hr/sq ft	11580	3750	3410	2730
"K"—paste tube—Btu/hr/sq ft/deg F	273	273	273	273

Firebox temperature, deg F	±1400
Flue-gas temperature leaving furnace, deg F	±1200
Heat fired, Btu/hr—net heat	6470000
Furnace efficiency, net heat, per cent	65

Heavy-oil recycle pump P-9 is a steam-driven plunger-type surge pump. It returns hot bottoms to the preheater at 750 F and 10,000 psi pressure. The pump is separated from the hot valve block and cold clean flushing oil is the surge medium.

P-10B is a 40-hp motor-driven vertical triplex variable-stroke injection pump and is used in flushing-oil service mainly to determine its adaptability for this type of work.

HIGH-PRESSURE TUBING, FLANGES, FITTINGS, AND VALVES

Tubing. In selecting standard tube sizes for 10,300 psi working pressure for different temperature ranges, consideration had to be given to process flow requirements, prevailing tube-manufacturing practices, permissible working stresses at moderate temperature, creep stesses at high temperatures, and to the effects of corrosion, erosion, and hydrogen attack.

Considering the maximum allowable stress, it was quickly realized that many theories are offered to explain the failure of thick-walled cylinders from excessive internal pressure, giving widely different results at the 10,000-psi design level. The maximum-principal-stress theory, in which the tangential stress alone is considered, proved to be the most suitable selection.

Three different temperature groups were set up for the selection of tubing materials: Low-temperature up to 375 F, medium-temperature service, 376 to 850 F, and high-temperature 851 to 1000 F.

For the low-temperature group seamless API-5L grade C was selected which has a maximum allowable stress of 22,900 psi at 375 F. Identical tube dimensions were secured through the three temperature ranges by selecting alloys of similar strength at their respective maximum operating temperatures. This resulted in accepting a 9 per cent chrome, 2 per cent molybdenum alloy normalized and drawn at 1200 F for the medium range and AISI type 316 stainless steel for the high-temperature services. Standard tube sizes range from $^3/_8$ in. to $2^1/_2$ in. ID.

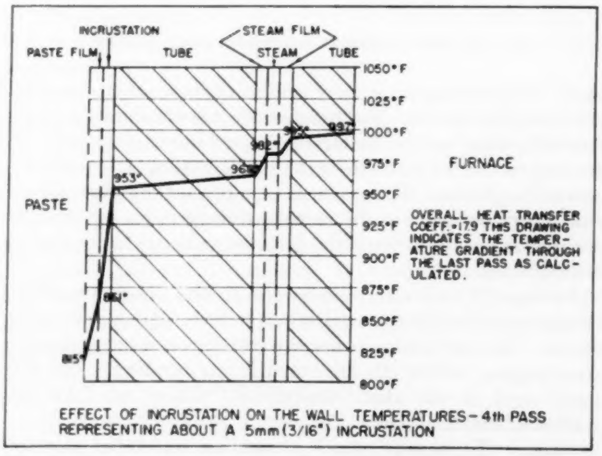


FIG. 7 TEMPERATURE GRADIENT THROUGH TUBE WALL IN LAST CELL OF PASTE PREHEATER

Flanged Joints. Since flanged joints for 10,000 psi working pressure are beyond the scope of existing ASA standards, new ones had to be devised. The German lens-ring type was chosen because it proved its dependability in more than 20 years of commercial service and had the advantages of minimum weight, lowest bolt load, and maximum flexibility of a ball-and-cone seat. The tube ends are beveled to a conical seating surface and are threaded for the flanges. A soft-steel lens-ring gasket with spherical surfaces seals the conical end of the tubes. Joint tightness can be achieved with a total bolt load of $2^1/_2$ times the total fluid load based on the area within the lens-seating surface. Weight of a $2^1/_2$-in. lens-ring-type flange is about 50 lb, the same as a $2^1/_2$-in-size 2500-psi ASA standard flange. Low-temperature lens gaskets are solid. For the medium and high-temperature services, the bellows-type lens gaskets are

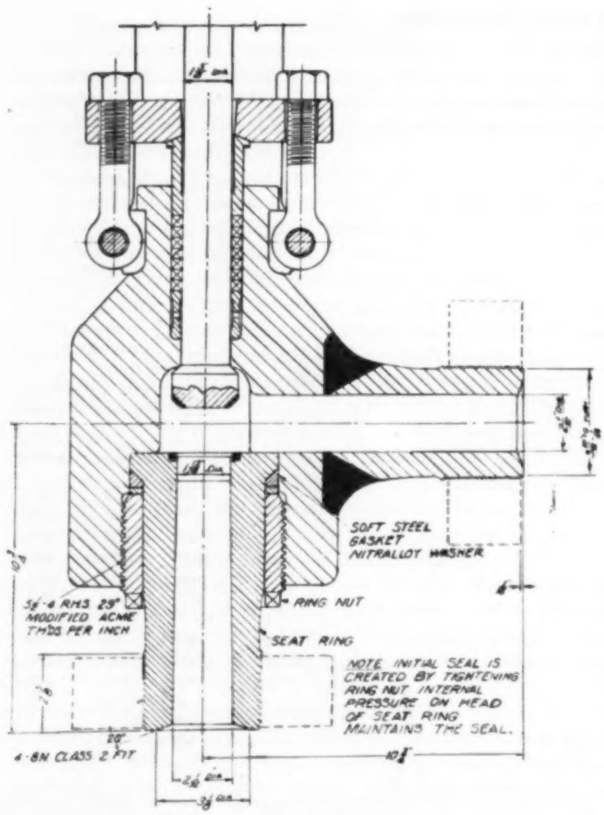


FIG. 8 HIGH-PRESSURE SHUTOFF-VALVE ASSEMBLY

used. This type gives greater flexibility required in expansion at high temperatures. The bellows effect is obtained by cutting a radial groove on the inside of the semifinished gasket, and drilling two small holes from the inside gasket face to the bottom of the groove. The gasket is then pressed together, leaving a small hollow space at the bottom of the groove, in which the pressure is equalized with the pressure in the tube by the two drilled holes.

Fittings. The fittings, all forged to the same dimensional standards as the tubing, are limited to tees, 90-deg ells, and reducers. The tee blanks are bored to the required inside diameter after forging, while ells are bored before bending. The three steels used in the three temperature ranges are SAE-1030, AISI-304, and AISI-316.

Valves. The shutoff, check, throttling, and relief valves are specially designed adaptations of conventional angle valves for this high-pressure service. Fig. 8 illustrates a 2-in. shutoff valve. The hard-metal insert on the bearing surfaces of both seat and disk is characteristic of all high-pressure valves. Stellite is used in this case. The Excelloy disk is integral with the stem, and the seat is made removable. Note the self-sealing feature of seat-ring closure which permits easy disassembly for replacing valve seats.

The severe-throttling valve, which is quite unusual, is designed to reduce the pressure of the heavy-oil slurry from the hot catchpot pressure to near atmospheric. In this valve the released solid particles strike the Stellite-lined target plate at high velocity. The special hard metal parts, assembled in a cartridge, are readily removable.

EXTENSIVE INSTRUMENTATION

Instrumentation was used more extensively in Louisiana than in the European commercial plants. This was done to facilitate collection of ample process data, to reduce operating man-power requirements through automatic control to the customary level of the modern American oil refinery, and to boost throughput to the maximum by continuous maintenance of optimum reaction conditions. Most instruments are adaptations of existing industrial practices; however, special designs were necessary for the measurements of small differential pressure at 10,000 psi for level and flow-rate controllers. Most high-pressure instrument tubing is $^{3}/_{16}$ in. ID $\times$ $^{9}/_{16}$ in. OD, type 304 stainless steel. All fittings are stainless-steel cinch-joint type. Valves are straight-through needle stops and angle checks.

Space will not permit discussion of low-pressure auxiliary operations, such as the coal preparation, paste preparation, heavy-oil centrifuging, flash distillation, product recovery, distillation yard tankage, and distribution of utilities.

POWER REQUIRED

The total power demand of the plant, including hydrogen generation and compression, is less than 4000 kw. Process and power-steam requirements total about 100,000 lb per hr. Steam and power are generated in the former Missouri Ordnance Works power plant. There are three pulverized-coal-fired steam generators, each capable of producing 145,000 lb of steam per hr at 415 psi pressure and 750 F temperature. The three 7500-kva steam turbogenerators operate at 400 psi and 745 F with 50 lb back pressure. Power is generated and distributed at 13,800 volts. The plant has its own service water-pumping and treating systems.

SEVERE SERVICE REQUIREMENTS

During plant construction it was found that neither the average American manufacturer nor the construction forces realized fully the severity of the service in a coal-hydrogenation plant. After the design was completed in painstaking detail, and reasonably severe specifications were drawn, repeated difficulties were experienced with their enforcement. The importance of careful supervision, inspection, and testing during every step of the fabrication and installation became evident. Standards of excellence, applicable up to 2500-psi service conditions, were not necessarily good enough for 10,000-psi work. In numerous instances flaws in materials and unsatisfactory workmanship were not brought to light until after shop tests or even after delivery to the job site.

It became evident at an early stage that the demonstration-plant program was fulfilling several of its main functions. During the construction and break-in periods, many process and design improvements were developed. In addition manufacturers gained considerable knowledge in high-pressure design and fabrication methods—a long step toward preparing them for building full-scale plant equipment.

The second phase of the work will be the demonstration of the operation of an integrated plant, producing synthetic liquid fuels from coal. During this period, operating data will be collected, analyzed, and interpreted in order to determine the effects of operating variables upon the processes and products. This will point the way to further improvements and refinements. Studies will then be made of the economics of the process to determine the cost of products and the investment required for commercial-scale operation.

Finally, engineers and operators will be trained in the required skills of the new industry and reports will be written for the purpose of disseminating all the technical and economic information developed in the demonstration-plant program. Thus the road toward an economically sound synthetic-fuel industry must lead through the actual construction, operation, and improvement of demonstration and commercial-size plants.

Problems and Significance of Our ALLIANCE *With* SOCIALIST EUROPE

By FREDERICK S. BLACKALL, jr.

PRESIDENT, THE TAFT-PIERCE MANUFACTURING COMPANY, WOONSOCKET, R. I. MEMBER ASME

ONE of the disconcerting things about the relationship of Europe's economy, and England's in particular, to ours is that we tend to follow Britain's excursions into the more abundant life with great regularity, but with a time lag of perhaps 10 to 20 years. The "New Deal" was old in England long before Franklin D. Roosevelt made it a battle cry. Encouragement of unionization, a measure of Social Security, the unemployment dole, all of these and others were in full fling in Europe way back in the days when a Republican still could get himself elected to office. If history is going to repeat itself—and Mr. Truman's recent inaugural address would indicate that it might—it is something to give us pause, for in my humble opinion, England's very status as a great nation is being threatened by the National Socialist movement which has gripped its economy. The destruction of incentive, the extravagance in spending without thought as to how the bill will be paid, the substitution of hope for a factual weighing of consequences—all of these concomitants of a regimented society are infecting poor old England with a creeping paralysis. It is destroying the very characteristics which have made her great.

This is not my view alone; it is shared by great numbers of thinking Englishmen; yes, by the overwhelming majority of *thinking* Englishmen. Indeed, there is considerable evidence that things have been brought to this pass by what really is a minority of the people. In the manner of Socialists everywhere, the minority has been united, while the loyal opposition has been hopelessly split. Consider the following excerpts from the recent remarks of Captain E. C. Eric Smith, chairman of England's great National Provincial Bank, Ltd., which were circulated with his annual report for the year ending December 31, 1948:

"A considerable attack on inflation was launched early in the year, but it has not fared too well. Coal is a case in point. Coal is, in effect, a rationed product, and yet its price has risen enormously. This is an instance where the extravagant cost of production and administration has pushed up the price although the element of competition is absent. A similar situation obtains in many places. The inflation lies more in the increased cost of production than in the competition for scarcity.

"One of our principal tribulations is the enormous volume of Government expenditure; there appears to be no effort either to recognize it or to restrict it. The cost of subsidies and social services is forever mounting. No one will question the desirability of social services, but they should be on a scale which the country can afford and their cost should not be the subject of optimistic estimates. As a recipient of aid from a foreign country, it is hardly decent to aspire to a standard of living we cannot ourselves support. While foreign aid may not directly contribute to the cost of the social services and such benefits as the shorter working week and longer holidays, it is undeniable that without it an even greater diversion of resources to the export trades would be necessary. To this extent our present standard of living is being indirectly subsidized by America. The bulk of the electorate is quite oblivious of the fact that social services must be paid for; it accepts them as a gift from its present rulers and ignores the fact that with the assistance of America, it is paying for them itself. How many occupants of council houses, while complaining of the amount of rent they have to pay, realize that that rent is but a portion of the economic rent and that the balance is paid by taxation and rates? A deflationary right hand remains in ignorance of, or ignores, the activities of an inflationary left hand.

NATIONALIZATION

"The nationalization of industry has proceeded steadily throughout the year, but it is clear that the technique of running nationalized industry has still to be learned. Every such industry that drops out of the true profit-earning category not only imposes an additional burden on those industries which remain within it, but also entails a loss of revenue which must be made good from other sources.

"The country could not survive as a solvent entity with its major industries run on the Coal Board pattern and functioning as pensioners.

"It is curious that the nationalization-minded with a mass of undigested coal, transport, electricity, and gas before them, should seek to extend their activities still further by the addition of the iron and steel industry to a collection already unwieldy. This industry is performing great feats of production, is well organized and enjoys better labour relations than almost any other in the country. Directly and indirectly, it is a very large contributor to our exports. It is efficient and progressive and the backbone of many other industries. The principal disadvantage from which it has recently suffered has been the nationalization of coal.

CONTENTIOUS LEGISLATION

"In order to bring it within the orbit of nationalization, it has been necessary to pass the most contentious legislation whereby the constitutional relationship between the two Houses of Parliament has been altered. The metamorphosis here is not yet complete, but in searching for the origin of this irrational intention one can only conclude that a limited number of men of intelligence have surrendered to the ideologies of a number of men of limited intelligence.

"To what other industries it is intended to extend the benefits of State ownership we shall no doubt learn in due course. *L'appetit vient en mangeant*. It is sustained by the hunger for certain political objectives and by the hunger for planning. The country is assuming the shape of a business with an overhead which its turnover cannot support. Its head is becoming unduly swollen at the expense of its hands.

"During the past three years the birth-rate of committees, councils, working parties, and kindred bodies has surpassed all previous records. Their propagation is one of our most thriving industries and salvation largely depends, apparently, on the

Address presented at the Spring Meeting, New London, Conn., May 2–4, 1949, of The American Society of Mechanical Engineers.

results of their deliberations. It is probable that the country would benefit were this time and energy directed to running its industry instead of talking about it."

THE SAME PRINCIPLES APPLY HERE

All too many of these remarks could apply with equal force to our own political-economic picture. We resist the name of Socialism, but do we really resist its substance? Perhaps these things can't happen here—but it is significant that Mr. Truman threatened to build steel plants at a time when steel production was the greatest in our history. If the Government were to invade this bastion of free enterprise, how long would the steel companies remain in private hands?

Twenty years ago, such a proposal would have created a profound shock; it would have been regarded, as indeed it is, as wholly foreign to American tradition and ideals. But Socialistic concepts, such as nationalization of industry, lose their terror when we read of them every day. Indeed, the danger is that in our close contact with Europe, which is Socialistic in own way or another from the Arctic Ocean to the Atlantic and the Mediterranean, we shall become accustomed to the Socialist philosophy and forget that it is the very antithesis of the principles upon which our nation was founded and through which it rose to greatness. Ironically, we decry Communism while our leaders have the effrontery to hold Socialism over us as a threat. The very fact that the President's statement on steel did not evoke universal hostility shows how far our minds have been conditioned to the acceptance of a philosophy which is completely antithetic to our institutions. I was going to say "can destroy the American way of life" but alas, through this very same sort of mental conditioning to alien ideals, the phrase is losing its force and begins to excite ridicule.

It is not alone geographically that we no longer are isolated from Western Europe. We have lost our intellectual isolationism, too. To a point this has its merits; but remember, not their wars alone, but their mass thinking can spread to our shores.

Already we are allied with Socialist nations (and what else is there beyond our own borders?)—allied with them in the effort to stem the fanatic imperialism of another Socialist nation. I wonder if this seems as ironic to others as it always has to me.

By no means do I advocate withholding of Marshall aid, but in granting it, I think we should understand what we are doing. We are not fighting Socialism, not even Communism. We are simply erecting defenses against potential aggression. The dictatorship of Stalin, the world revolution, the Kremlin's imperialistic aims, none of these has anything to do with Russia's economic philosophy. The dictatorship is but the appropriation of power by a few individuals, a phenomenon as old as history. It is wholly unrelated to Socialism. The world revolution though Marxist in origin, is simply the Messianic complex in action—the fanatic urge of the one-track mind to impose upon the minds of others the views which it holds. The urge has utterly nothing to do with the views themselves. We suffered from this same sort of thing through fourteen years of prohibition. As for imperialism—that is either the spirit of conquest, or the erection of a defense, depending upon where you sit.

The point I am trying to make is that the basic philosophy behind Communism is not materially different from that which actuates Britain's Labor Party, for example.

EFFECT OF EUROPEAN AID ON OUR ECONOMY

So much for the impact of Western European ideas upon our own. But in the field of economics, the situation in Western Europe can exert a profound influence upon our own as well. Unless we are prepared to abandon the West altogether, it seems apparent that we must either support it financially, or assist it in becoming self-supporting. I don't need to stress the fact that we cannot pour six billion dollars a year into Europe indefinitely without a measure of inflation here, or at all odds without making some very genuine sacrifices. This is folding money, and, in the long run, all of us will have to pay the bill. But, you say, this is merely a temporary expedient, to be utilized only until Europe becomes self-supporting. Well, let's examine this. How is Europe going to become self-supporting? Obviously, she can do so only by producing goods and selling them. And she is not going to get very far on this tack if she is shut off from the richest market in the world, that is, our own.

Barbara Ward, in her provocative work, "The West at Bay," concludes that the only hope lies in a union of Western powers, including the United States. Certainly if not a union, we must have an entente of sorts, perhaps at a minimum a customs union. Many have espoused it, but if we wish real unity and the measure of security and defense which goes with it, we must make sacrifices not alone of dollars, but of some of our cherished economic principles, especially the principle of protection through a high tariff wall. If Europe ever is going to be able to provide her own dollar exchange, she can do it only through trading with us.

Thus, the question arises whether we have a sufficient sense of urgency in our desire for Europe to become self-supporting to be prepared to open our own doors to her? As individuals, we cannot resolve this question by advocating low tariff rates on the other fellow's product. If we want to measure how vital we feel it is that Europe should become independent of our financial support, we must ask ourselves to what extent we would be prepared to permit European goods in our own lines to be admitted to the United States for sale in direct competition with our own individual products. This is not an easy question to answer, nor a pleasant one; but the fact remains that we've either got to give our goods to Europe, or else let her buy them with her own goods. We must recognize once and for all that this is the choice; that if she is to buy our goods, she can do it only with dollars, and that she can secure dollars only by gift or by selling us goods.

The alternative of a loan exists, of course, and that at present is being emphasized—but bear in mind that a loan can be extinguished only by a gift or by the sale or exchange of goods. Remember that money—dollar exchange, for example—is only a symbol. The exchange must be of goods for goods (or services), unless we are to continue to give Europe the money with which to buy from us, and that means merely giving her the goods for nothing, which we now are doing. Certainly we cannot do this indefinitely without bankrupting ourselves.

THE WORLD'S LEADING NATION

All of this suggests that, in the give and take of our mutual postwar readjustment, we must be willing to give not only of our money, but, what may be harder for us, some of our cherished attitudes and methods in respect to foreign trade. Whether we like it or not, we are cast in the part of the world's leading nation. This role which England played conspicuously during the nineteenth century is surely ours for the second half of the twentieth. But it must not be forgotten that the conditions which enabled England to play it so well were brought about through a fortuitous accident of history. It just happened that the industrial revolution occurred on a little North Sea island whose very life and existence, as its population grew by leaps and bounds, depended on the importation of all manner of goods. Small wonder that there flourished in such an economic climate manufacturing and production based on

foreign trade. England's mills and factories sent out their manufactures to the four corners of the earth and received in exchange the raw materials with which to make them, and the produce with which to feed her population. Free trade was her lifeblood, and under it she achieved an industrial might unthreatened until the great Colossus of the West, our own United States, grew to adult stature behind tariff walls under an almost self-sustaining economy quite unlike that under which Britain's industry had come to full flower.

If we are going to implement President Truman's clarion call to bring the benefits of Yankee civilization to the faraway regions of the globe, we first must condition ourselves to the acceptance of the products of these regions in payment for our own goods and services. This means a wholesale readjustment in many segments of our economy. In many a case it will mean new competition, for we, to a far greater extent than England ever was or ever could be, are a self-contained nation. Not that we are, in fact, independent of other sections of the world, for the most cursory inquiry would reveal our utter dependence in our national security and welfare on certain of the commodities and products of other regions. What should we do without nickel, manganese, mercury, chromium, tin, rubber, to mention only a few? But at least we can feed and clothe ourselves with the products of our own soil. Imported materials have played but a minor part in the creation of our gross national product, and so a certain isolationism and a want of interest in foreign trade took early root here. A national policy based on such considerations served well enough in a simpler period but will scarcely be adequate in an era when oceans are spanned in a few hours' flight, and a single bomb can blow a great metropolis to smithereens. Nations must devise ways and means of living together in amity, one of the first requisites of which is to eliminate economic maladjustments—of all factors, probably the greatest single source of international strife. I don't see how this objective can be accomplished without something approaching the free movement of goods in international commerce. It seems inevitable that our peculiar relationship to Europe will force it upon us.

OUR MOTIVES UNDER SUSPICION

Let it not be thought that we shall earn any particular gratitude for the largesse which we are distributing under the head of Marshall aid. Indeed, there is ample evidence that quite the contrary will be the result. There is already a tendency to question our motives. The British delegate to the recent conference of the Western Union nations in Paris felt it necessary to assure his colleagues that General Marshall after all was not one of the wolves of Wall Street. It is not alone from the Kremlin that one hears our efforts characterized as simply another manifestation of Yankee imperialism.

On a recent trip to Europe, I found no real appreciation of either the breadth or the depth of America's sacrifices in World War II or of the determining part which America played in the allied victory. Appreciation—yes, here and there—in the sense of a certain measure of gratitude among persons of broad intellect; but little comprehension of such fundamentals as these highlighted by Mr. Bernard Baruch in his brilliant article, "A Few Kind Words for Uncle Sam."[1] This article should be read by everyone, because many do not realize the following facts; certainly few in Europe do:

OUR WAR CONTRIBUTION

That American military casualties exceeded those of the entire British Empire in both dead and wounded; that of the 90 divisions which stormed through Western Europe, 61 were American; that the initial landing waves in all but a few of the beachhead assaults on the many Pacific islands were carried by forces either wholly or primarily American; that American dead numbered more than 400,000, with nearly 670,000 additional wounded, as against total casualties for England, Australia, Canada, New England, South Africa, and the Colonies aggregating only 353,652 military dead, 475,070 wounded, 90,844 missing, and 60,595 civilians dead. That their casualties totaled 980,161 against our nearly 1,070,000; that with some 14,000,000 men and women mobilized and under arms, we still produced 60 per cent of all allied munitions; that our expenditures exceeded those of Great Britain and Soviet Russia combined; that we made outright gifts in wartime aid to our allies of over forty billion dollars after full allowance for all reverse lend-lease and other settlements; that of all the belligerents, only the United States really fought a global war; that during the five war years our arsenal of democracy produced nearly 300,000 airplanes, 15,000,000 rifles and carbines, 319,000 pieces of field artillery, 41,000,000,000 rounds of ammunition, 4,200,000 tons of artillery shells, 86,000 tanks, 64,500 landing craft, 52,000,000 tons of merchant ships—an average of three ships a day—quadrupling our own merchant fleet; that while doing this, our Navy grew nearly sevenfold, from 1,900,000 tons to 13,000,800, a tonnage greater than the combined fleets of all of the rest of the world. That in addition to equipping our own armed forces, we supplied food or munitions or both to 43 different nations.

In spite of this record, the average European, even the average Englishman, still looks upon the role we played in World War II as primarily an outpouring of dollars, small enough recompense, in his view, for our being spared the terrors of the bombings and the blackouts. You will find precious little warmth of view toward Americans in the British or Continental press.

IMPULSE IS TO REVERT TO ISOLATIONISM

The danger is that Americans, by tradition and emotion somewhat isolationist, shall take themselves at the value which others place upon them and chuck the whole troublesome business of foreign aid and interallied support. Or at least try to, for I doubt if we could chuck it if we wanted to. The fact is that these cold and uncomplimentary attitudes toward us are largely born of jealousy and envy, qualities which, however ignoble, are eminently human characteristics.

The business executive, for example, knows all too well that no matter how hard he may try, the boss is never a particularly popular guy. His position of leadership and power, if not incompatible with popularity, at least makes its achievement an extremely difficult affair.

Uncle Sam, whether he likes it or not, has become the world leader—a position in which he only recently has displaced John Bull, who, however glad he may have been to give up the responsibilities of the job, still looks back through amber glasses, in the manner of human beings everywhere, to the good old days. Nor can he forget that it is his somewhat recalcitrant offspring who is now riding in the saddle.

I, myself, of Anglo-Saxon heritage and virtually undiluted English blood lines, often am intensely aggravated and annoyed by what I regard as the ignorant, unthinking, frequently ungracious and ungenerous attitude of many of our British cousins toward us, but even my limited grasp of human philosophy and my understanding of human nature tell me that this is a natural thing which should be viewed in proper perspective. It never should be permitted to disturb the underlying and fundamental bond of human interest and sympathy which exists between the two great English-speaking

[1] "A Few Kind Words for Uncle Sam," by Bernard Baruch, *Saturday Evening Post*, vol. 220, June 12, 1948, pp. 15–17; also *Reader's Digest*, vol. 53, September, 1948, pp. 9–13.

nations. It is a bond which both nations should foster and cherish with every power at their command. The implementation of such an objective requires, above all, a continuing effort toward mutual understanding on both sides of the Atlantic.

BRITISH SOCIALISM NOT FAR DIFFERENT FROM MARXISM

England's present political position presents certain difficulties in this connection. It is alleged, of course, that though British Socialism, like the Russian, has some of its roots in Marxism, it stems primarily from the Fabian Socialist and Christian Reform movements, hence is heavily conditioned by the Anglo-Saxon political tradition of the freedom of the individual. Considerable significance also is attached to the Labor Government's extreme sensitivity to any criticism that it is stealing away Britain's cherished liberties. Nevertheless, I suggest that it is doing just that, and doing it in a particularly insidious and deceptive way. The apologists for the Attlee Ministry point out that the Government undoubtedly would fall if the people felt that their basic rights, as individuals, were being attacked. In my view, this merely compounds the felony. The rape of liberty is no less a crime because it is committed while the people are lulled into slumber under the soporific promise of the more abundant life.

I have previously expressed the opinion that I discern little difference between the fundamental philosophy of a Stalin or an Attlee. To my way of thinking, they are intellectually birds of a feather, tarred with the same stick, alike as two peas in a pod. Bear in mind that I exclude from this characterization any considerations of a thirst for world supremacy, the world revolution, or an urge to dictatorship. These, are entirely extraneous factors and do not alter in the slightest the fundamental beliefs of the two men on economics or social problems.

That we should be completely out of sympathy with the objectives of the British Labor Government and its continental counterparts is natural in the light of our traditions and, may I add, it is eminently desirable that we should continue to be. But this lack of sympathy should not blind us to the fact that the two great Anglo-Saxon nations and the other democracies of Western Europe, Socialist democracies though they may be, must hang together or, as the old saying goes, hang separately. American concepts of liberty are based upon the premise that we must live and let live. However much we may disapprove of socialist trends in Western Europe, we cannot quarrel with the citizens of those countries if Socialism is what they elect by democratic processes to be their guiding principle. The thing we stand against, shoulder to shoulder with them, is the suppression of liberty and human rights through dictatorship. We who really object to the Marxian principle of world revolution—the fanatic's effort to impose his views on others—must take care that we do not seek to impose our views on others by force, be it economic or otherwise.

OUR AID MUST NOT BE USED TO SUPPRESS FREEDOM

Nevertheless, it is a perilous course which circumstances force us to pursue. The Socialist planned economy, first by definition limiting human independence, soon tends, as it has in Russia (and elsewhere), to generate dictatorship and the suppression of human rights. Thus, it is important that, in giving aid to the Western democracies, we condition our assistance to such extent as we can (and we must recognize that this is not always possible) with the provision that our aid shall not be used, directly or indirectly, to finance further excursions into nationalism or other systems repugnant to our principles of human liberty and freedom of enterprise. This is not forcing our views on others; it is merely stipulating within reasonable limits how our money shall be spent, or rather how it shall not be spent—a thing which we have every right to do.

The grave danger of our close alliance with Western European Socialism is that we ourselves may become infected with it, as indeed to an extent we already have been. I often think that America and England, whose spirit and traditions are linked so closely with our own, are running a race with time. Will her far-reaching experiment with State Socialism so deaden her once great spirit of enterprise, will it prove so manifestly unworkable that prostration and bankruptcy of a once mighty nation will stand as a living lesson to us that it must not happen here? Above all, if these things occur, will they occur in time to warn us? Or better—and pray God it may be so—will the utter incompatibility of the planned Socialist economy with Anglo-Saxon concepts of freedom and the dignity of the individual become apparent soon enough to convince her people, as well as ours, that it is after all unworkable; that the middle road is vastly superior to that beguiling left-hand thoroughfare which, however paved with good intentions, leads straight to economic disaster, hell, and damnation?

To quote Mr. Bernard Baruch again, "The American system hasn't produced perfection, but it has brought the people further along in their pursuit of happiness than any other system. Why change our form of government when we can use that government to make whatever changes we desire?"

FREEDOM A TREASURED BULWARK

Happily, we possess one bulwark which often is overlooked. Our nation, probably more than any other, constitutes democracy in its purest form. From the very days of the Declaration of Independence, our Government and our traditions have been based on the principle that all men are created equal. Just what do we mean when we say this? Obviously, not that the ignoramus is the intellectual equal of the college president. No, what we mean is that every man shall have equality of opportunity, economically, spiritually, socially. In a practical manner we have practiced that principle far more effectively than any other people on earth. We have no ruling caste; we have no nobility, no bourgeoisie, no peasantry, no proletariat. In this we differ markedly from most of the other democracies. When they substituted the democratic principle for autocracy, they still retained their social classes. It has been this, probably as much as any other single thing which has made the common people of these nations fair game for the social reformer. We require no socialistic panacea to give our people liberty, equality, and fraternity in the fullest sense of the word. We possess these attributes already as the inalienable rights of a free people. Our major task is to preserve them, to hold our gains, the most fundamental of which were made so long ago that we begin to forget that they are still new, still almost unique, in all the world.

I do not argue merely for laissez-faire and preservation of the status quo; neither do I suggest that all so-called social legislation is anathema. I do argue that it is good sense to weigh the benefits of all legislation against the sacrifices and the costs, whether spiritual or material, which it may entail. It may be a nice thing to be able to get your aspirin, a new wig, or a set of false teeth, for free, merely by filling out a government requisition in twelve copies, but if this involves taxing all of the incentive out of industry and pauperizing the individual, then I say that the price is too high. Also, we need to get rid of our serious attack of the "gimmes."

It makes little sense to me to pension every veteran if the real producers among them—and that means the great majority—will have to pay through the nose for it for the rest of their days. Neither does it add up to wisdom to place a premium on loafing, through a universal unemployment dole, or to give me free medical service when I can afford to pay for it, just because

(Continued on page 588)

PREPRODUCTION PLANNING *for a* NEW PLANT

By HENRY A. MARTIN

WALLACE CLARK & COMPANY, MANAGEMENT CONSULTANTS, NEW YORK, N. Y. ASSOCIATE, ASME

THIS is a story of the collaboration between engineers in two American countries—the United States and Canada. It is an account of the collaboration between the management of a Canadian manufacturer and a consulting management firm, in planning and controlling the entire course of construction, installation, and the first months of operation of a new plant. The spirit of co-operation in all of the work on this project was an important factor in the success of all of the planning.

Planning can be autocratic, with all plans dictated by a small group on the top-management level, or it can be democratic with all of the people who are concerned with a problem participating in the planning. In this case the developments which are described were worked out by a planning committee consisting of engineers working in a three-way collaboration, and with the people in Canada who were actually to operate the plant after construction.

FACTORS INVOLVED IN PLANNING A NEW PLANT

The engineering of a new plant is often regarded as applying primarily to the civil and mechanical aspects of planning the construction and installation of process equipment. Also important, but not often considered as an integral part of the planning, are the considerations of personnel, markets, and management methods to be used in operating the plant after it is constructed.

Our client, a Canadian manufacturer, decided late in 1946 to construct a plant to produce mineral-wool fibers, commonly used as an insulating material in construction and industrial applications. The Canadian market was at that time supplied by imports from the United States, and sufficient volume of sales had developed to warrant establishing a plant in Canada. The Canadian company was to do the actual engineering, planning, and procurement for the new plant, based on plans and specifications developed by its engineering staff.

As a first step, preliminary estimates of potential sales were developed. These were used in preparing engineering estimates for the plant and equipment required. The resulting plans and specifications were then turned over to engineers employed by the Canadian manufacturer. This group was responsible for work with architects and constructors in procuring the buildings, as specified. In addition, their work included the preparation of purchasing specifications, and the selection of Canadian manufacturers to undertake the fabrication of the necessary equipment for the new plant.

Construction of the plant was commenced in 1947. By early spring of 1948, work had reached the stage where it was imperative to make definite plans for the operation of the plant, namely, to begin detailed "preproduction planning." Every plant has some degree of preproduction planning before operations begin. In process industries, such as this plant, which operates on a continuous basis, 24 hours a day, 7 days a week, it is a vital necessity. Once the plant is in operation it cannot be shut down or slowed up, without extra expense, while gaps in planning are plugged up. Absolute planning is required to bring all problems into focus in advance. This is preproduction planning—the things that must be done in concert and completed before the new plant is ready to run.

The essential elements of preproduction planning for this plant were as follows:

What range of products would be made and in what quantities?

What materials would be required?

What equipment and work methods would be used?

What production cycle and personnel would be used to produce the planned quantities?

What methods would be used for control?

(*a*) Organization.

(*b*) Routine procedures.

(*c*) Executive reports.

Construction and basic equipment installation which are allied to this preproduction planning were considered in the overall schedules that were set up, to insure that all work would be completed in the correct order and in the shortest possible time.

The author's firm, which was retained by the Canadian company, was concerned with the preproduction planning and management aspects of the new plant. This meant collaboration with the engineers on construction and equipment installation, as well as work with the management groups, in order to insure that all planning was co-ordinated.

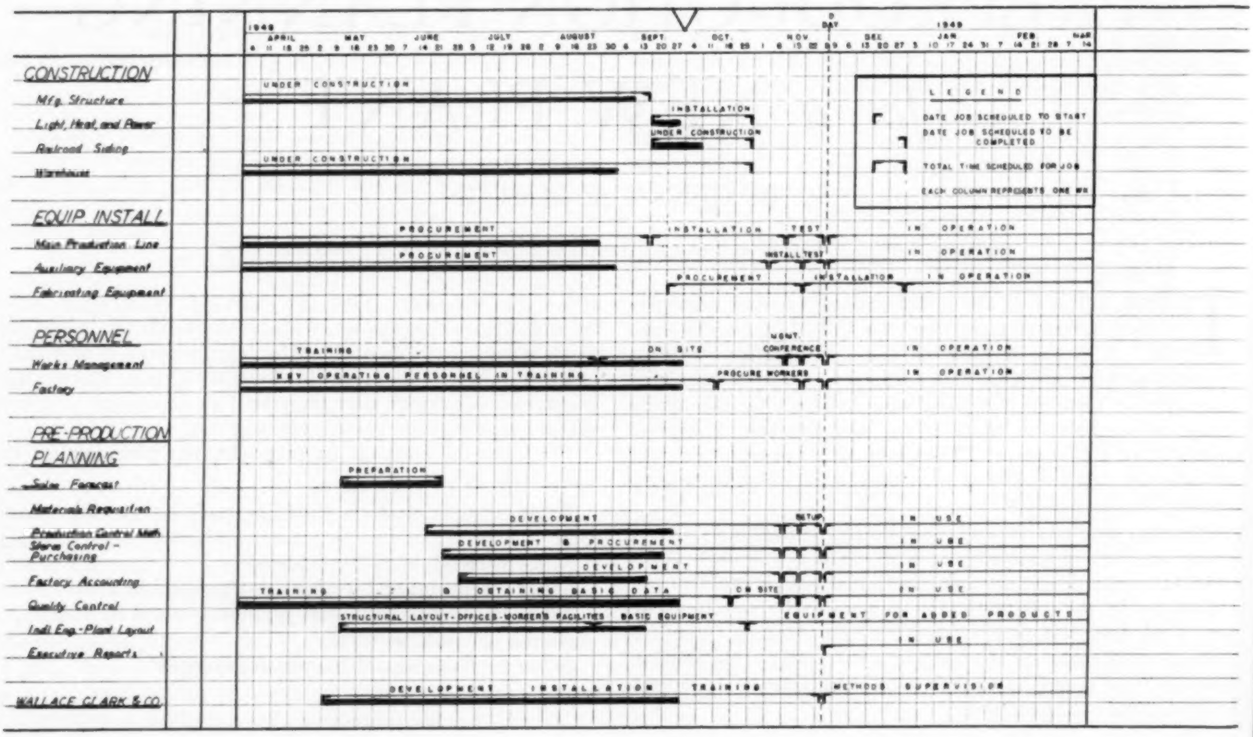
Gantt planning charts, successfully applied to engineering and planning work of all types by our company, were used to set down the important work items and the time required to complete them. The actual number of charts used is so great that it is not possible to include them in the present paper. However, a summary, which is in effect a synthesis of many actual charts, has been prepared to demonstrate the method and to show graphically the chronological relationships of the elements listed in the foregoing.

The Gantt Chart 1 illustrates the method of planning and controlling the work of constructing a new plant and getting it into operation with a minimum of delay. As stated, this is not a reproduction of the actual schedule, but is a condensation of many pages of detail. This is done in order to show the entire span of time and all of the work. This simulated chart shows true time relationships on the project discussed but is not real as to progress or delays.

The horizontal space, reading from left to right, represents time. The date line at the top indicates that each vertical column equals one week, and that December first is "D-Day," when it is desired to start actual operation of the plant. On the left side of the chart are listed the major classes of work which must be done to complete the plant and place it in operation. Opposite this listing, the time period during which each work element must be done to meet D-Day, is blocked off as follows:

To be presented at the Pan American Engineering Congress, Rio de Janeiro, Brazil, July 15–24, 1949.

CHART 1 SUMMARY SCHEDULE: PREPRODUCTION PLANNING



An angle opening to the right shows the planned starting date, an angle opening to the left shows the planned completion date, and the light line joins the angles to show the duration of the work period.

The actual progress of the work is shown by drawing a heavy line under the light schedule line. At the time of posting progress a large V is placed at the top of the chart to show the date on which the progress was measured. The position of the progress line in relation to the posting V shows whether each element is behind schedule, on schedule, or ahead of schedule, and by what amount of time.

A glance at the chart reveals that the most serious delay is on installation of the main production line, which is seen to be five weeks behind schedule. The next two most serious delays are construction of the warehouse and installation of auxiliary equipment. Both are four weeks behind schedule. Personnel work, quality-control preparations, and the work of the consultants are exactly on schedule. Construction of the railroad siding is one week ahead of schedule.

From this chart the management sees immediately the areas which need special attention to permit starting production when planned.

PLANT AND PRODUCT

Before proceeding with the discussion of preproduction planning, it might be interesting to describe the plant and the processes. Mineral-wool insulation is produced from basic raw materials, or "batch." Sand, rock, limestone, and other ingredients, are melted in a furnace, or tank, and the resulting molten mass flows in streams which are blown into fine fibers. These fibers are treated with various binding materials, depending upon the end use of the product that is being manufactured. One very common binding material is resinous bakelite, which is sprayed on the glass wool and set by passing the product through a tunnel furnace on a continuous-chain conveyer. The process is a continuous-flow operation, with raw materials fed in at one end of the line, processed continuously through the melting furnace, through the forming and setting operations, and finally the packaging operation.

The basic raw materials are dense and compact, and present no storage problems. The finished product is extremely light and porous, with a very high proportion of bulk for weight. A considerable amount of storage space is needed and there are many problems of materials handling due to the special nature of the product. To illustrate this, two weeks' production of this plant requires a total storage area of almost 100,000 sq ft of warehouse space. Depending upon the density of the product that is made, this plant will produce up to 15 carloads of material per day. It is evident that close control of operations is mandatory to avoid overproduction and improper distribution of inventory.

The plant consists of four units as follows:

Batch house, for storing and mixing raw materials.
Furnace hall, where the melt is produced and formed.
Main manufacturing building, where the end product is fabricated and packaged.
Warehouse for storage of finished products.

It must be remembered that this plant was planned and constructed at the end of the war, and that shortages of materials and labor were still prevalent. Similar process equipment had been built many times in the United States for plants erected there, but because of conservation of dollar exchange there was extra work in specification preparation and interpretation to secure Canadian manufacturers who could build the equipment. All equipment was successfully built in Canada, except for certain items which came from the United States.

Construction of the plant itself presented the usual problems of delays and setbacks in the schedule of construction, but the main source of delay and uncertainty was the procurement of the equipment. The application of the planning techniques to the construction and equipment installation will be

discussed later. Essentially, this phase of the problem was the responsibility of the engineering departments and not a part of the work of the consulting firm.

PERSONNEL SELECTION AND TRAINING

It was important to provide intensive training of plant personnel and to start this training far in advance of the time when the plant would be ready for operation. Actually, some of the personnel were selected almost as soon as construction started. At the time we began our assignment, more than one half of the technical and supervisory personnel had been hired and were in training. One interesting feature of the supervisory personnel of this plant was the fact that of a group of about 30 technical and supervisory positions, all but four were filled by men with degrees in engineering or one of the sciences. Further, most of the men were in the same age group, the late 20's or early 30's. In the course of training and work, incident to setting up the plant, such a homogeneous group developed a very excellent *ésprit* which had much to do with the successful start of the plant.

A distinction should be made at this point between the works management group and the supervisory forces. The plant manager, the assistant plant manager, the works accountant, the production planner, the industrial engineer, and others, constitute the planning and management staff for the plant, or the works management group. Some of this group must be technicians but all of them are primarily concerned with the management of the plant, assisting the plant manager in developing policies, plans, and operating procedures to guide the activities of the plant supervisors and operating personnel. The supervisory group in the plant is composed of technicians who have the line function of supervision of all operations.

For this plant, it was decided that technical personnel would be trained in one group and that the works management group would be assigned to work with the operating staff of other plants owned by the company, so that the management routine and procedures developed for the new plant would parallel those used by other plants of the company. Completion of training for both groups would be phased to coincide with the physical completion of the plant. Here we have an example of training by doing. The intention was that the production planner, the industrial engineer, and the plant accountant, would work together as a group in developing procedures for stores control, production planning, timekeeping, production recording, and the other elements of management techniques for a factory. Because the actual technical processes are dominant, it was necessary to make visits to other wool-insulation plants to secure basic data on production rates and processes, which could be built into the standard production controls for the new plant. From data thus secured, and from routines in effect in the other plants of the company, the works management group developed parallel standard operating procedures.

PREPRODUCTION PLANNING

It should be made clear that the essential elements of preproduction planning were taken into account at the time the decision was made to build the new plant. Consideration was given to the probable sales volume, to determine whether or not a plant could be justified economically; studies were made of plant location, shipping facilities, availability of labor, and estimates of the cost of production. However, many of these estimates were only in sufficient detail to permit broad decisions. There was no real sales forecast in terms of product breakdown, with estimates of quantities to be sold by product, or with allowances for seasonal variations. On the other hand, there was a considerable amount of detail on quantities of batch material required, since this information was a primary factor in designing the storage silos for batch material.

The first step in preproduction planning was to secure a sales forecast. All further preproduction planning was dependent upon estimates of the amount and kind of product to be sold during the first year of operation. These planning factors are as follows:

- Raw-material requirements.
- Packaging material requirements.
- Storage and warehouse layouts.
- "End of line" layouts.
- Shipping routines.
- Storage and handling methods.
- Detailed cost estimates.

In preparing the sales forecast, the Sales Department of the Canadian company was handicapped by the fact that the war years had not been normal in terms of sales, and the statistical summaries of sales were not complete and of doubtful accuracy for the intended use. As a further complication, there had been embargoes and restrictions on imported goods, which had tended to cut down sales, despite demand for the product. All of this meant that the sales forecast for the first year was truly an estimate, with large elements of guesswork in so far as the breakdown of quantities of particular products or packages was concerned.

Material Requirements. After the sales forecast was prepared, it was possible to proceed with the next step of preproduction planning, that is, the determination of requirements for the various materials and the placing of orders for them, with definite delivery dates on the requests for purchase. The determination of requirements was a matter of securing specifications from the company in the United States and translating the specifications of finished product into requirements for raw material and for the various types of packaging material, such as cartons, paper, labels, and steel tape. Once the quantities were determined, it was possible to convert them into cubic footage of warehouse space needed for storage of raw materials and for the storage of finished products.

As has been said, this entire project is an example of collaboration between groups of engineers working on different parts of the same project. The works management group could determine what materials were necessary, but before orders could be placed specifying delivery dates, these schedules had to be tied in with construction schedules. For example, the pouring of concrete floors was so late in the construction schedule that there was danger of material arriving before storage space was available. However, integration of the two planning schedules was successful and no materials arrived before space was available; conversely, no essential material was lacking on the day that the plant was scheduled to start operation, even though the delivery schedule was very tight.

Layout for Warehouse and Other Stores Areas. When the original engineering design was prepared for the new plant, the total amount of warehouse space was estimated, but there had been no estimate or preparation of detailed plans which would fix the location where any particular item was to be stored.

Preproduction planning for the warehouses consisted of determining requirements for production materials, as previously described, and of calculating the necessary cubage and square footage of stores area. This was relatively simple for the production items, because exact specifications were available for the amount of material required to produce any item in the line; and, of course, specifications were available on the pack-

aging and storage requirements of finished products. This was mostly a matter of calculation after the sales forecast was prepared.

However, the storage area for maintenance materials, refractory stores, and other special stores items for this plant were much harder to estimate. There had never been a plant of this exact nature before, so that there was little in the way of experience to fall back upon. Hard work on the part of the industrial engineer and the plant engineer was necessary to develop proposed lists of stores materials which could be reviewed by qualified personnel to determine what would be needed, and the stores facilities entailed.

When the original plans for the warehouse were drawn, rough estimates of the total area indicated that there would be ample space for the storage of finished goods, maintenance material, refractory stores, and all other items just discussed. First estimates and allocations of space exceeded this figure, but this portion of the planning was undertaken in time to make the necessary adjustments before the plant opened. There were no questions left unanswered as to where material would be stored, questions which would have taken valuable executive time for decisions, had they been left until material arrived at the plant.

Factory Layout. In a plant of this nature, the basic layout is determined by the fixed equipment such as the furnace, and the main production line. This was determined when the engineering design was made. However, the preliminary engineering had covered only this aspect, and no planning had been done for the auxiliary manufacturing processes and equipment, or for working out the detail of material flow from the end of the line to shipping or storage. The process used in preproduction planning for this problem is well understood in most engineering circles today.

Gilbreth process charts were prepared for the main product lines, showing the flow of material. From these charts, layout drawings, with equipment and machine templates drawn to scale, were made and the location of the auxiliary manufacturing areas was fixed.

In conjunction with this work, an equipment record for the plant was also set up. It is customary for the accounting departments in most manufacturing plants to maintain an equipment ledger wherein the annual depreciation on equipment is recorded and written off. Often, in a new plant, this essential record is not set up as purchases are made, with the result that there is an incomplete record at the time the plant starts operating. In this case, the industrial engineering, accounting and purchasing departments, collaborated on a planned program of equipment analysis and records, so that complete records were available for the purposes of management when the plant was constructed. A further by-product of these records was a plant-equipment file for the maintenance department to use in setting up schedules of inspection and lubrication, anticipating the preventive maintenance program.

Production Methods. It was necessary for our engineers to study the processes and to develop full data on production standards, that is, man-power requirements, time standards, allowances for machine setups, lost time, and similar factors used in production planning and in establishing standard costs. The routine for production planning, as set up for the new plant, was quite similar to the production-planning routine which was used in other Canadian plants of the company which was setting up the mineral-wool plant. Basic data were gathered and converted to the needs of the new plant.

A complete procedural description of the routine of production planning was prepared by the industrial engineer and by the production planner. These routines began with the receipt of a sales order in the sales department at the head office of the company, and set down the regulations for handling this order from that time, through transmission to the factory, and the entire routine of filling the order from stocks in the warehouse, or by custom manufacture. During the preparation of this procedure, the sales department was asked to specify the items in the product line which should be kept in stock, and those which would be manufactured to order only. As far as possible, all of the requirements of the sales department were anticipated and plans made for meeting them. These included methods for handling rush orders, orders for special packaging, change orders, and cancellations.

As the studies of production methods progressed, it was possible to amplify and refine the estimates of man power for the operation of the new plant, and to anticipate the amount and type of prior training that would be needed for the clerical and production-planning staff.

Cost-Accounting Routines. Essentially, the cost-accounting routines in any manufacturing operation are closely related to the production planning and recording, which is necessary for factory operation. As previously stated, the production standards for each item were used to establish standard costs. In this case, it was possible to prepare an integrated reporting routine which served the needs of the production planner and the plant manager, as well as the needs of the cost department and the time-keeping and pay-roll groups.

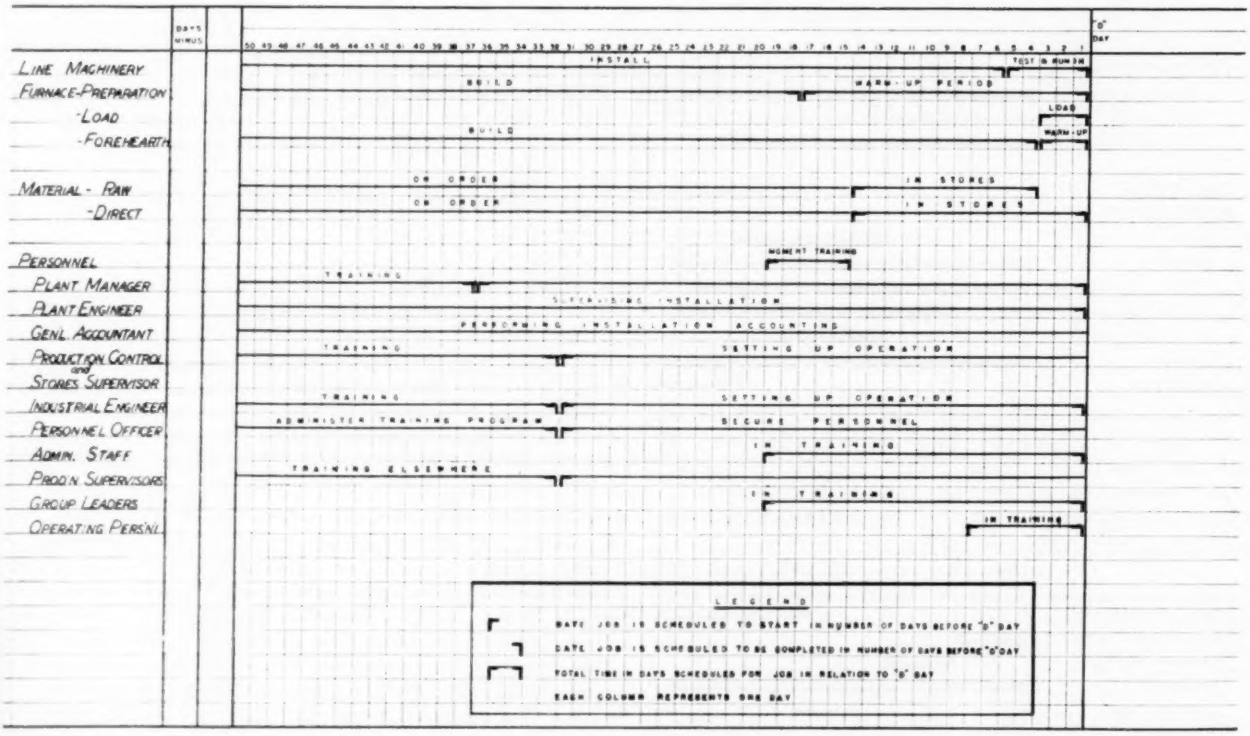
All of the so-called paper-work routines for this plant were developed in detail during the preproduction planning period, and tested by review and discussion with all of the interested supervisory personnel. The intention was to have established, as far as possible, written procedures to cover every phase of plant operation. These written procedures were used for training purposes in the weeks immediately prior to the start-up of the plant.

Of the total number employed in this plant, including both supervisory and hourly workers, only about 12 per cent of the personnel had the benefit of advance training. The majority of the foremen and all of the hourly workers were hired just prior to the starting day, and therefore had little or no advance training. This need was filled by a very complete set of written instructions for each job, which could be used for training purposes. In addition, there were complete procedures written to cover each phase of the operation so that there was adequate reference material to be used for job training.

Scheduling. During the early part of 1948, while construction of the plant was proceeding and while the preproduction planning previously described was under way, these two phases of work could proceed almost independently, with exceptions such as planning the delivery of certain materials. The technical group was in training; the engineering group was engaged in supervising the construction of the plant and the procurement and installation of equipment; and the works management group was engaged in the management engineering phase of preproduction planning. Each group was aware of the work of the other, but there was no real need for an overall schedule at that time.

However, in June, 1948, it was decided that some more definite planning was required in order to control the training of the technical group, and to decide when they would be brought to the plant site. The date when the plant would be ready to start operations would be the limiting factor for this decision. Owing to uncertainties on delivery of vital equipment, no fixed date could be estimated. Accordingly, it was decided to use the same technique which the Armed Services had used during the war in planning specific

CHART 2 D-DAY PLANNING CHART FOR NEW PLANT



landing operations, i.e., D-Day. The device used here was to establish D-Day, without a date, and then to count back in time the number of days before D-Day, when certain actions would have to be taken. In this particular plant the furnace was constructed in time for necessary preparatory and preliminary firing. It was known that this heating-up period would require a fixed number of days. This established a specified date before D-Day, when the fires in the furnace would be lighted. This date, in turn, set up other dates when it would be necessary to bring specific technical employees to the plant; it also fixed the time, in days, when other personnel, who did not require so much training, would have to be hired.

We reproduce a single sheet from this D-Day schedule, as Chart 2, which illustrates the technique that was used. The chart at this time is primarily concerned with personnel. No attempt was made to fix dates for completion of construction or for the installation of fixed pieces of equipment. The schedule was set up to plan essential action which had to be taken at the time and was expanded later when other action became critical. All concerned with the project knew that the executives of the company were anxious to have the plant in operation as soon as possible.

As work progressed through the summer, the delivery dates on equipment became more definite and by September, 1948, it was possible to revise the D-Day chart and actually bring in the elements of construction and equipment installation. Instead of a D-Day with no fixed date, a definite starting date of December 1, was established. This planning schedule was much more detailed than the D-Day chart, and fixed definite dates and responsibilities for all of the remaining work that had to be done before the plant could start. Parts of two pages of this schedule are reproduced as Chart 3. The upper chart is a portion of the summary sheet of the schedules. Each principal subdivision of work is shown, such as outside and inside work, and equipment installation. The total time required for each of these major subdivisions is reserved on the chart. The lower portion is one of the supporting sheets of this schedule, which gives more exact detail on the work planned.

From September onward, preproduction planning was largely a matter of following the progress of work that had already been laid out and scheduled. Each responsible supervisor and officer in the company knew exactly the work that was required of him, when it must start, and when it must finish. The principles which were followed are outlined in the following quotation from Mr. Clark:

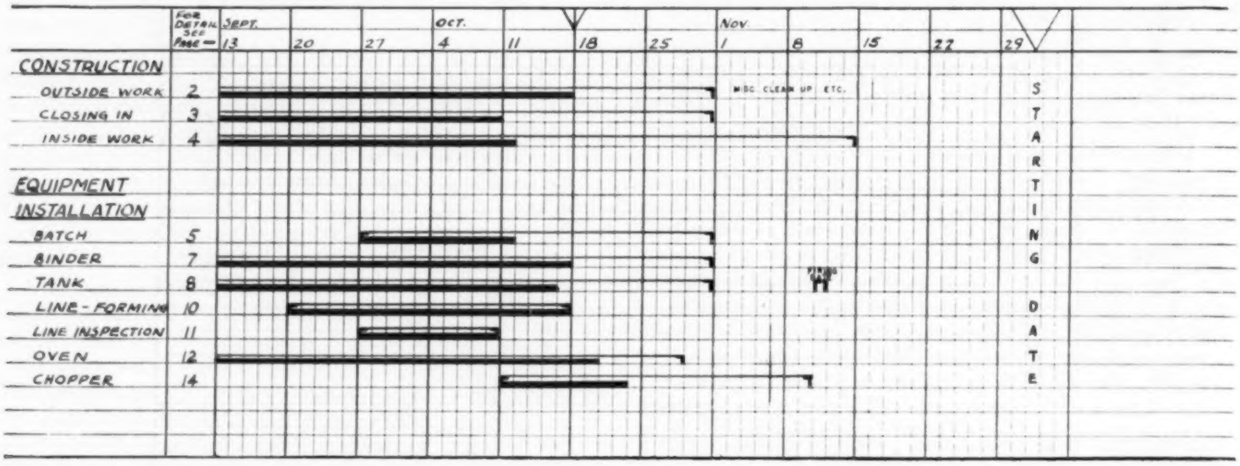
"Practical planning puts its emphasis on the date when work must start in order to meet an established deadline. It is not sufficient to establish a deadline, and call that planning. Each step along the way must be considered and a time relationship for that step established in conjunction with the final deadline date."

In November, 1948, a month before the plant was scheduled to open, a review of the master schedule showed that installation of equipment was about 1 week behind schedule, and that some items of construction could not possibly be completed prior to the date set for opening the plant. However, there was sufficient detail on the planning chart to determine that the plant could still open as planned, provided urgent action was taken on the lag items that could prevent operations.

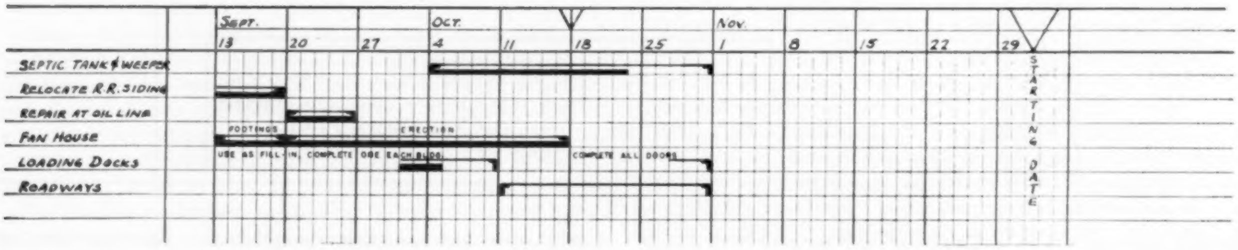
Eighteen days before the plant was scheduled to operate, a similar review of the situation was made to determine if the schedule could be met, and if the fires in the furnace could be lighted. While certain items were still not up to schedule, there was enough information to enable the responsible executives to calculate the risk involved and to make the decision to proceed as planned.

It was not until the day before the plant was scheduled to start work that the final critical items arrived. On exactly

CHART 3 SUMMARY SCHEDULE: CONSTRUCTION AND EQUIPMENT INSTALLATION



DETAIL SCHEDULE: CONSTRUCTION—OUTSIDE



the date scheduled, December 1, the plant went into operation. Products were packed and ready for shipment in the first 24-hr period of operation. Thus, two years of co-operative preplanning had achieved its objective.

SUMMARY

Complete planning of all phases of this project brought the following advantages, which could not have been gained otherwise:

1 There was full utilization of manpower, with no lost time. Gantt planning charts, showing manpower trained and available, were used to determine when and where men could be assigned to specific jobs.

2 Co-ordination of the efforts of a large number of executives, at several locations, was assured. Planning charts and progress reports kept these men fully abreast of problems at the new plant, with exact information for executive action.

3 A definite date for production to start was established months in advance, which enabled the sales department to plan an adequate sales campaign and to accept orders with definite delivery promises which could be kept. Meeting the scheduled start-up date and delivering goods as promised, were important assets in building up customer good will for the new plant.

As industrial know-how passes from country to country, there will be many opportunities for the application of democratic planning methods such as were employed in this Canadian plant.

There was effective collaboration between the engineers of two countries, several companies, and three branches of engineering—civil, mechanical, and management or industrial engineering. Similar situations will be experienced in our expanding Pan-American economy. Engineers know how to work together. It is through the use of such democratic methods and techniques, and with such common thinking and understanding that the engineering profession can make its greatest contribution to peace.

WHAT is needed in America is intellectual toughness, born of intellectual struggle, and resting upon a foundation of values built during that struggle. I have no fear of the conclusions which professional men, thus educated, would reach, for I have full confidence in intelligent procedure and place top value upon intellectual freedom. What I do fear is a teacher or an administration that insists on telling the student, in a partisan spirit, what the answers are—or what the teacher thinks they are. What is needed throughout higher education, as I view it, are more teachers and administrations that will insist on students achieving the second and especially the third stages of competence in regard to values, and will take the time and have the patience to solve the extremely difficult educational problem that is involved. For it is very far from being solved today.

But the stakes are high. The development of a new breed of professional men who not only can perform effectively in the technical part of their work, as they can now do, but also serve the additional functions I have outlined, may be a very important factor in the endurance of America. (From a talk on "Value Judgments in Professional Education" given by Robert E. Doherty at the dedication exercises for the new electrical engineering building at the University of Illinois, May 20, 1949.)

AMERICAN ENGINEERING *and* INDUSTRY ABROAD

By LLOYD J. HUGHLETT

EDITOR, McGRAW-HILL INTERNATIONAL CORPORATION, NEW YORK, N. Y.

MORE than a few young engineers today are considering careers in the foreign field. Names such as Meiggs, Billings, Goethals, Minor Keith, Braden, Frederick Harte, and others represent a spectacular chapter in the history of the United States' contribution to the early development of other countries. The pioneering of these men was succeeded by thousands of American engineers who followed their leadership into the foreign field. Today the number of engineers required and working abroad is greater than ever before. Since the turn of the century, opportunities offered by the foreign field have increased as the world gradually entered into an era of national interdependencies. The resources and strength of the United States are being called upon to take a leading role in world-wide developments. Engineers today will go abroad and accomplish feats which will immortalize them in the annals of countries in process of development. Their exploits may be less spectacular than those of the pioneers who hung railroads across the Andes on sky hooks, created a vast network of hydropower for southern Brazil, conquered the jungles of Central America and opened it for trade, discovered the black gold and mineral wealth of Peru, Chile, Colombia, and Venezuela, and opened the rivers and harbors of the other Americas to travel and trade.

The need still continues for engineering facilities to exploit the natural wealth of countries; but the need is also being extended to educate peoples in the skills of efficient production and in the economics of management as they become self-sufficient, well-clothed, well-fed nations capable of participating in world trade.

With the world's mechanical progress and the philosophy of internationalism permeating and coloring all our thinking, it is appropriate that we attempt to estimate at this time the opportunities and demands placed upon our engineering services and industry in foreign countries.

EXPORTS TO MEET THE NEEDS OF FOREIGN COUNTRIES

Any forecasting of the foreign demands placed upon U. S. industry for management and engineering services must be postulated upon a careful examination of our export record. These exports in turn must be broken down to determine the relative proportions of capital versus consumer goods. Industrial and heavy construction equipment is the basis for foreign industrialization; nondurable goods represent production targets for which the industrializing countries aim to become self-sufficient.

Over-All Export Picture. To attempt here a world-wide analysis of trade would be too extensive an undertaking. By limiting ourselves to a kaleidoscopic review of Latin American trade, we will cover the field in which American industry and engineering are primarily interested. Also, we will restrict our analysis to an area with a more or less similar pattern of industrialization offering the greatest market for U. S. engineering technology and capital.

Reaching an all-time peak in 1947, the value of U. S. shipments of industrial equipment to Latin America totaled $474,000,000, nearly 800 per cent greater than in 1938, and 82 per cent higher than in 1946. Although U. S. total exports soared to 306 per cent over the average of 1941–1945, the physical volume remained about the same, due to inflation. An examination of the records of engineering companies over this period reveals that their foreign business is directly correlated with our sale of heavy equipment abroad.

Spearheading the present demands for equipment and raw materials in Latin America are the industrialization and extensive modernization programs of Brazil, Argentina, Mexico, Chile, Venezuela, Cuba, Colombia, Uruguay, Peru, and Bolivia. These are the "Big 10."

They account for 95 per cent of the power generated in Latin America, 97 per cent of all industrial workmen, and 97 per cent of Latin American imports from the United States.

There definitely was a decline in our total exports to Latin America during 1948. However, these cuts have been in the fields of consumer and luxury goods. The brakes have been applied to luxury imports by various countries in an effort to conserve their dollar balances. Dollars will be used for the purchase of capital goods needed to obtain self-sufficiency in such fields as textiles, foodstuffs, cement, petroleum, basic chemicals, paper and pulp, and power generation. With the exception of Chile, the Big 10 of Latin America are importing U. S. machinery in almost direct ratio to their production of power.

Exchange and import controls are generally exercised by all Latin American countries. Everywhere, except in Cuba and Venezuela, stringent restrictions are in force to curtail consumer-goods imports. Indirectly, these restrictions benefit the industrial and construction-equipment suppliers here in the United States. In the Big 10 countries, where the establishment of manufacturing facilities to supply consumer goods is a major target, an increasing number of measures are being introduced to protect local industries. Tariff barriers, however, are not being raised against industrial machinery in Latin America; to the contrary, such equipment will be admitted tax-free in order to encourage new and expanding industry.

The Latin Americas, like other industrializing areas of the world, have recognized that their economic expansion must stem from an internal growth in technology communicated to them from the industrialized countries. By importing engineering and management skills, they seek to attain a stronger trading position, being able to sell as well as buy in the international market.

New industry, based upon imported industrial know-how, will make it possible for Latin American countries to produce many durable and nondurable goods, to complete projected public works which will raise living standards, to increase

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their purchasing power for all types of goods, and in turn to contribute to the further diversification of their productive facilities.

This is the program Latin America faces in improving its trading capacity. U. S. industry recognizes healthy signs of growth and foresees opportunities for participating in the industrial development of several Latin American countries. Undaunted by difficulties of exchange, inefficient labor, limited national markets, and an oftentimes unstable political scene, many U. S. companies are migrating to these countries. By introducing their experienced technology of management and manufacturing skills, they work hand-in-hand with national capital in the creation of new factories and industrial plants. In not a few countries, however, conditions are not judged favorable to the expansion of U. S. interests.

This is not a particularly new phase of export; but it is a development which is receiving increased attention by many manufacturers who wish to penetrate the foreign market. For other manufacturers, the establishment of a foreign manufacturing operation represents a logical means for holding markets which otherwise would be reduced substantially or lost to them entirely because of exchange difficulties or preferential trade arrangements.

Survey Conducted. In order to accumulate objective information regarding the opinions, attitudes, and trends of (1) engineering firms, and (2) U. S. manufacturers regarding the foreign field as outlets for their services and the establishment of manufacturing plants, two questionnaires were circulated among these groups.

One questionnaire went to engineering companies to determine the percentage of their business abroad, the countries in which they have projects under way, the nature of their services to foreign clients, special difficulties or opportunities experienced in doing business abroad, the branches of engineering most frequently required in their foreign operations, and supporting questions to supply details on these principal points. Engineering companies numbering 400 were approached by letter; 120 replies were received, representing a 30 per cent return (Table 1).

The other questionnaire was aimed at manufacturing companies and was intended to discover their attitude toward branching out into the foreign field either in wholly owned plants or plants jointly financed with foreign local capital. Other questions were directed toward ascertaining their position in loaning personnel and "exporting" technological assistance to put such foreign plants into operation, licensing of their products for manufacture abroad, areas considered favorable for such manufacturing operations, and whether they consider foreign manufacturing operations stable, financially profitable, and to be recommended to other U. S. manufacturers. About 2000 company presidents received this questionnaire. Answers were received from 728 companies, slightly better than a 36 per cent return (Table 2).

The questionnaires were substantiated further by interviews with various manufacturing and engineering firms, in order to obtain additional details as described in this paper, verification of results gathered from the questionnaires, and interpretations of opinions and attitudes which obviously would be omitted in replying to any questionnaire.

Foreign Industrial Requirements. A review of the economic plans, formulated by countries throughout the world, reveals that for the large part each has a program of development. In some of the smaller countries (specifically Latin America), the industrialization schedule has been entrusted to government agencies which directly or indirectly control almost all new development or modernization work. In several instances the influence of these agencies extends to control over dollar exchange for imports of goods and services. In the larger countries, industrialization is a function of an over-all planning agency with more freedom being left to development through the initiative of private enterprise. In other countries, however, there is a trend toward centralization of the powers for industrial development into government hands.

In primitive countries, industrialization can be initiated only by the government itself. Private enterprise is completely in-

TABLE 1 SUMMARY OF REPLIES TO QUESTIONNAIRE SURVEY AS SUPPLIED BY 120 U. S. ENGINEERING FIRMS ENGAGED IN OR INTERESTED IN DOING BUSINESS ABROAD

Value of foreign business?	
Information not supplied (84 companies)	...
Percentage of total business (36 companies)	18
Value of capital investment abroad?	
Not available	...
None (105 companies)	105
Average of 11 companies	$700,000
Will you sell engineering services alone?	
Yes	117
No	3
Will you construct a plant as well as provide engineering for it?	
Yes	86
No	34
Do you have a working arrangement with other companies to supply engineering services which you yourself cannot supply to your client?	
Yes	80
No	40
Do you do any manufacturing of equipment that could be sold to plants engineered by your company?	
Yes	14
No	106
Have you facilities for handling the purchasing of equipment required in plants engineered by your company?	
Yes	112
No	8
Can you handle product development for foreign manufacturers?	
Yes	16
No	104
Do you anticipate an expansion in your foreign operations?	
To be the same as at present	19
Yes	58
Interested in getting into the foreign field	31
To decline	12
Countries offering the greatest engineering opportunities? (In order of perference)	
Latin America	1
Canada	2
South Africa	3
India	4
Europe	5
Near East	6
The greatest difficulties to sale of engineering services abroad?	
Dollar shortages	24
Lack of contacts with clients	47
Expressed no opinions	49
How many engineering graduates do you employ full time in the U. S.?	
26 companies employ less than	9
28 companies employ between	10–49
25 companies employ between	50–99
36 companies employ more than	100
5 companies provided no information	...
What emphasis do you place on employing national engineers in your foreign operations?	
Considerable	41
No answer or indefinite answers	79
Do you train national engineers for the administration and operation of projects which you have engineered abroad?	
No answer	39
Yes	69
No	12

TABLE 2 SUMMARY OF REPLIES TO QUESTIONNAIRE SURVEY AS SUPPLIED BY 726 U. S. MANUFACTURERS

	Yes	No	Undecided
Would you consider manufacturing your products abroad?	226	277	223
Have you made analyses or surveys in consideration of such a step?	39	681	...
Have you been approached by or contacted any foreign interests with respect to manufacturing your product abroad?	128	598	...
Would you consider licensing your product for manufacturing abroad?	377	240	109
Would you consider entering a joint undertaking with foreign capital to establish a manufacturing plant abroad?	264	293	169
Would you be in a position to loan the personnel and export the technological assistance to put such a foreign plant into efficient operation?	211	186	329

What foreign areas do you consider the most favorable for manufacturing your products?

Canada	1
Latin America	2
Europe	3
South Africa	4
Near East	5
India	6

capable of undertaking any program for creating manufacturing facilities, since industry and business of any size have not yet been established in the country. Therefore it becomes a responsibility of the government to start the ball rolling, to create and financially support a plan which will put new manufacturing facilities into the country. As these industries become self-sufficient in management, finance, and efficient production, the government should withdraw its influence and permit them to operate according to the internal economic character of the country. So long as government controls serve as a beneficial instrument to industrialization and do not restrict the operation of private enterprise, such government development corporations meet with the goodwill of U. S. industry. When they result in centralized buying agencies, favoritism toward special interests, artificial price fixing, tariff barriers, and state-controlled industrial economies, they obviously become opposed to the principles of free enterprise.

ENGINEERING IN THE FOREIGN FIELD

American construction engineering generally precedes the exports of capital industrial goods, while U. S. labor and management skills accompany their installation and use in a developing factory system. Industrializing countries have already employed our engineering to construct or supervise the construction of their public-works programs. U. S. contracting firms, consisting largely of civil and structural engineers, are called upon to provide the personnel and heavy equipment necessary for the creation of transportation systems, dredging of harbors and rivers, construction of pipe lines and water-supply systems, and the erection of commercial and public buildings. In so far as our survey has been able to determine, a conservative estimate of at least 90 per cent of the income derived from U. S. engineering in the foreign field today is routed through the large contracting firms employed to handle the public-works programs of countries abroad.

These U. S. firms are spearheading the industrial developments which follow their construction jobs. As harbor facilities are constructed to open countries to foreign trade, highways and railroads fan out through the hinterland from coastal cities, and populations learn the value of health and sanitation facilities, then industrial plans can be realized to produce foodstuffs, textiles, raw materials, and a large variety of consumer goods. This has been the history of areas with centers in Buenos Aires, São Paulo, Mexico City, Capetown, Tientsin, Hangkow, Sydney, Bombay, and Manila.

Many of the large U. S. contracting firms in the heavy contruction field do a substantial share of their business abroad. Several have specialized in foreign work and their projects abroad range between 60 and 90 per cent of their total business. Not a few of these companies are individually doing over $10,000,000 of business a year abroad.

It is further worth noting that they attribute the success of their foreign work directly to the experience gained on foreign jobs abroad over a great number of years. Because of their accumulated knowledge of local working conditions and laws, a personnel adapted to the requirements of living abroad, ability in calculating costs on foreign jobs, a capacity for working with local labor and materials, and experience in making contractual and financial arrangements differing from practices in the United States, these companies have enjoyed profitable operations in the foreign field as contractors and builders.

The construction field, as largely based upon civil engineering, differs considerably from the opportunities offered to other branches of engineering. The engineering required for power-plant design and construction, petroleum refineries, and chemical plants comprises an increasing percentage of foreign con struction activities. Engineering firms handling the largest share of business abroad in these fields are staffed with engineers in these specialized branches of engineering, work with the client in conceiving and planning a project, carry it through its design, and finally contract for its construction.

The consulting engineer has generally played a very limited role in the foreign field. Unless he has been retained by some large U. S. company to supply a highly specialized service on a foreign project, his services simply have not been in great demand by foreign companies or governments. Nevertheless, there are a large number of engineers who are interested in developing a consulting practice in the foreign field. Not possessing the facilities of the larger engineering companies for handling or evaluating credits and risks, moving funds from abroad, providing the experienced personnel for a project, professional registration in the country, and unfamiliarity with local legal requirements, the individual engineer or small consulting firm is faced with problems which may endanger the success of foreign operations. It is worth noting in this connection that companies reporting successful operations abroad have always taken the precaution of covering their services with letters of credit or other guarantees of payment in U. S. dollars. Smaller 1 to 4 men consulting firms have mentioned delays in receiving payment for their services or encountered other difficulties which are generally avoided or quickly solved by the experienced larger companies. However, the majority of firms replying to our survey have indicated that they expect their foreign business to increase or to remain as at present.

The value of engineering advisory or design services is generally not appreciated by a foreign company. The position of the consultant is not recognized as an economical and direct means of facilitating the selection of a plant design, purchasing of equipment, and as a means for obtaining specialized engineering services.

This point was very clearly brought home to the author recently by a visitor from one of the smaller countries in the Caribbean area. He was up here to purchase a half million dollars of mining equipment, and wanted our advice and help in contacting manufacturers and suppliers. He wished to purchase the same type, size, quality, and so forth, of equipment used on a very successful mining operation in Canada. He did not take into consideration the differences in ores, labor, power supply,

and other conditions existing in Canada and in his own country. He was, last of all, not a mining man. The immediate suggestion to him was that he employ the services of a competent mining engineer as a consultant, and that the author would be happy to supply him with the names of half a dozen reputable and competent men in the field. He could employ the services of one of them not merely for helping him in the selection and purchase of equipment here, but also for supervising its installation at the mine site and putting it into operation. He was hesitant about following such a procedure and, pressed for the reason why he did not care to employ such assistance, he finally answered, with some diffidence, that he felt consultants were "confidence men."

Furthermore, it was the feeling of the visitor that such engineering assistance should be supplied by the manufacturers of equipment—a viewpoint commonly held by the majority of capital-goods purchasers outside the United States. Many engineering firms have remarked that this attitude militates against the sale of engineering services. In South America, for example, this attitude was developed as a result of the prewar experience with German manufacturers. They would provide services which are outside the range of free development work that an American firm can furnish a client today.

Foreign companies and even governments feel no obligation in asking a U. S. firm to submit complete data outlining processes and machinery requirements so that they can decide whether or not they wish to invest in a proposition. They request such information simply as a routine part of their shopping tour. Most U. S. firms are now asking for a retainer before undertaking any investigations or study whatsoever. It has become the general rule, moreover, with the majority of engineering firms successfully operating in the foreign field today, to include their services in the cost of the equipment. Several export houses will provide their clients with complete plants on this basis. Their practice is to quote a total plant cost and include in it their engineering expenses. It would seem that engineering firms should be recommended to follow this procedure since it has become the customary means of getting and doing foreign business. Ninety-seven per cent of the engineering firms participating in our survey stated that they were able to do the purchasing of equipment required for plants which they design. However, only 70 per cent were in a position to erect a plant abroad and install the machinery in it. Engineering services as such are oftentimes cleared for dollar exchange only with the greatest of difficulty, although they may be more easily paid for when included within the cost of equipment sold, even when it is higher than regular goods rates.

Many manufacturers also will provide the entire engineering details which may be required for the development and sale of a plant. Although they may not manufacture all units entering into its various operations, they will include the units of other manufacturers for which they can easily supply specifications. One large company, with subsidiaries in various heavy-equipment fields, can present a prospective client on several hours notice with preliminary plans for plants of various capacities in almost any industrial field. With a strong sales force operating in the foreign field, such a manufacturer obviously offers considerable competition to the average engineering firm. Their "packaged" plants have the additional sales advantage of being tried and proved in the foreign field, employing units produced in mass production, being based upon simplified designs which have an advantage where semi or unskilled labor are involved, and an over-all lower cost.

An obstacle to undertaking foreign engineering work, which our survey uncovered, was the lack of contacts between prospective clients and engineering firms, in other words, getting business. This issue was mentioned by several of the larger engineering companies and stressed by the majority of the smaller firms. Unlike manufacturers who undertake a strenuous campaign of advertising to interest potential buyers in choosing their products over those of their competitors, engineering firms depend upon personal contacts or upon a prospective client hearing of his work record or specialization.

Several of the large engineering firms enjoying several decades of successful operation in one or more countries, have immediate contacts with jobs as they develop. This is made possible by maintaining active representation in selected areas. They are on the ground floor of new projects and little publicity is released on them in the United States.

Visitors to the United States to assign jobs and interview different firms have recently begun to enlist the help of consultants. They are beginning to get over the idea that they are mere "confidence men." Through these aides they are assisted through the banking systems in Washington and New York, are put in contact with specialized engineering personnel after a screening which is done by their counsel, and oriented to the resources of the American industrial system.

There is considerable promise abroad in the field of management engineering. Unfortunately, few foreign companies as yet recognize the value of this service and even more are not even conscious of its existence. As the various factory systems of different countries evolve, there comes a stage in their development where they require experienced guidance to achieve proper plant efficiencies, handle labor problems, maintain qualities of production, and market their products successfully. Although a foreign industrialist may be quite aware of his need for this service, he is not familiar with the fact that specialized organizations exist which can fill his needs. Management engineering, furthermore, is faced with no small task in selling its services to foreign industry. Such services cannot be expressed in terms of so many dozens of pumps, tons of piping, or shiploads of structural-steel shapes. Foreign manufacturers find it difficult to appraise the purchase of services as such; they do not represent concretely the new plants which are needed so badly, nor modernization of existing facilities which were up to date at the turn of the century.

The export of technology is primarily a long-range responsibility of private enterprise. Although the communication of production skills and engineering knowledge may be aided by government and education agencies, the fact remains that industrial technology and know-how are largely a property of private enterprise. The role played by U. S. capital and business in industrializing or reconstructing other countries is a potent means of selling the American Way abroad. U. S. capital goods being sold or lent abroad account for 12 per cent of total U. S. production and 35 per cent of the goods moving in world commerce. In almost all categories, their values are paralleled by proportionate requirements for U. S. engineering and technology in the importing countries.

Capital goods moving into an industrializing area are a challenge to the labor and management groups of that country. Attempts to create a self-sufficient segment of industry too rapidly have failed or proved unprofitable when countries have neither the maturity of management nor the existence of sufficiently skilled labor to establish economically sound manufacturing enterprises.

The importation of our management skills is the catalysis to accelerate industrialization and result in efficient and economic productivity. To achieve an intrinsically sound basis for industrial development within foreign countries, know-how furnished by United States industry must accompany our capital goods and dollars abroad. This exportable end product of research, carried over into production, stems directly from

the basis of what has come to be known as the "American Way."

U. S. INDUSTRY GOES ABROAD

U. S. business has an unprecedented opportunity today for introducing the American Way into foreign countries. It is in the unusual position of being able to go into partnership with foreign capital, to create new plants, and to invest its specific technologies in profitable foreign enterprise.

Spotlighted in today's public consciousness is the conflict between communism and capital. The means our Government has elected for stemming the flood of communistic propaganda and to promote world prosperity with ECA assistance is only part of the job. If the philosophy and operations of private enterprise are to be re-established in Europe and to take deep roots in the industrializing countries of Latin America, it must be accomplished in large part by U. S. private enterprise itself. U. S. business and industry as missionaries of the philosophy of private enterprise, as opposed to systems of state control, must literally move over the face of the world. They must invest in, engineer, and manage new enterprises as a means of combating the economic factor which is the common denominator of prosperity and security of all nations. The world has become a closely knit and finely balanced economic structure. Poor markets, unemployment, and depression in one area are reflected in reduced productivity and depression in another.

And, what is the attitude of U. S. business in facing a new international frontier for industry where the responsibility of promoting and participating in foreign private enterprises rests squarely upon their own shoulders?

An undercurrent running throughout the 726 replies from manufacturing companies would seem to indicate that a very large segment of U. S. business is becoming more internationally minded. The fact is not surprising in itself when we recall the nature of the world we are living in, and its daily reporting in newspapers, trade journals, and popular magazines. Our international role in world politics and world recovery has colored the thinking of all of us. U. S. businessmen are taking stock of the broader field of internationalism which we have entered and are translating it back and measuring its implications against their own business. This constitutes a radical departure from the traditional attitude of many U. S. manufacturers whose values were postulated on producing for and selling in the domestic markets.

TABLE 3 ATTITUDES OF 726 U. S. COMPANIES TOWARD FOREIGN MANUFACTURING OPERATIONS

	Yes	No	Un-decided	No answer
Do you consider foreign manufacturing operations financially stable?	213	327	135	51
Do you consider foreign manufacturing operations profitable?	269	138	193	126
Are they to be recommended to other manufacturers?	184	64	128	360

Our survey attempted to determine the relative interests of various types of manufacturers in expanding their operations into the foreign field. It was recognized that some companies do a very heavy export business. However, no special attempt was made to reach this group. Our sampling was based upon a cross section of industry by selecting blinding every fourth card listing the presidents of 8000 companies.

In analyzing our questionnaire returns, the attitudes of individual segments of U. S. industry toward manufacturing in the foreign field were carefully distinguished depending upon whether the companies were metalworking, chemicals, food-packing, textiles, etc. The viewpoints of the larger companies, since they have already expanded into the foreign field or explored its possibilities, differed from those of the smaller companies; while the medium-sized manufacturers manifested the strongest interests in foreign operations. Geographically, companies on the Atlantic and Pacific seaboards were more internationally minded than those in the midwest. Particularly did the young industries, warborn on the Pacific coast, express an interest in branching out into foreign countries. Beginning to feel the postwar competition of older industries, they are more favorably inclined to view any opportunities offered in the foreign field.

The manufacturers of heavy equipment logically point out the uneconomical features of trying to fabricate bulldozers, heavy prime movers, fractionating equipment, high-production machine tools, instruments for temperature and pressure controls, and so forth, in areas where the markets for such goods are not only limited in themselves but also may be restricted further by reason of trading agreements, exchange difficulties, and the like, with other countries.

Still other fabricators of heavy equipment are presently contemplating setting up manufacturing arrangements in other countries. Their foreign operations will for the large part employ sheet steel and various structural shapes, together with subassemblies imported from the United States, to assemble such typical products as water-treating plants, refrigeration equipment, motor-truck frames and bodies, carbide-tipped tools, valves, and small Diesel engines. Many of these new manufacturing enterprises represent American technology and patents combined with foreign capital and its existing metalworking facilities. A number of American chemical companies have also gone into the foreign field where they can practically overcome all competition by locally manufacturing basic acids, alkalies, and salts on which there is a low margin of profit when bought and sold on the international market. A similar joint partnership of foreign capital and U. S. technology for the industrialization of foreign countries has also been indicated by the McGraw-Hill survey in fields of leather manufacture, textiles, steel mills, the manufacture of soft drinks and alcohols, food-packing plants, and electric power.

Many U. S. companies operating in foreign countries are limited as to the amount of capital which they can hold in any company operating there. For the large part, such arrangements consist of 49 per cent of the capital being supplied by the U. S. interests with the balance being held by nationals. Other restrictions apply further in the case of exploiting subsoil wealth, hydroelectric resources, and the operation and ownership of various public utilities. In some countries there is a complete exclusion of foreign capital in such enterprises. Such restrictions have definitely slowed down the development of mining, metallurgical, and power developments in several Latin American countries. U. S. companies not merely have refused to undertake further development work in areas where such legal restrictions operate, but have pulled up stakes and abandoned the work which they already may have done.

Today most invitations being extended to U. S. companies to emigrate into foreign areas are on a partnership arrangement. U. S. companies are invited into such partnerships to supply management skills, engineering know-how, equipment, and certain part of the capital; the foreign interests provide clearance with local and national laws, real estate, distribution facilities, ability to work with local labor, and capital.

FOREIGN AND U. S. INDUSTRY MUST GET TOGETHER

The McGraw-Hill survey threw considerable light on the attitudes of the small or medium-sized manufacturer's interest toward branching out into the foreign field (Table 3). The history of how big business has gone into the field is fairly well known. The absence of interest or reluctance of many medium and small manufacturers to immigrate into the foreign field is twofold:

1 American businessmen are not sufficiently assured and confident of themselves in making such a step. They have heard much about opportunities in such areas as Latin America, South Africa, Australia, Canada, and the Near East. But also they are justifiably concerned with fears of expropriation, the freezing of their profits within the country, unskilled labor, labor troubles communistically inspired, absence of markets, populations with a low purchasing power, and other problems associated with distance and language differences. Unlike the larger companies who are acting as bellwethers to the present movement of capital and technology into the foreign field, very few of the smaller and medium-sized companies are as yet making the detailed analyses and comprehensive studies preliminary to taking such a step.

2 Probably the greatest obstacle to the migration of medium and small U. S. industry abroad is the absence of adequate machinery for bridging the gap between existing opportunities abroad and the actual acquainting and selling of U. S. private enterprise on the idea of taking advantage of these opportunities. The facts are (*a*) the industrial systems and governments abroad are interested in having U. S. capital come into their countries and participate in the development of industries; and (*b*) certain U. S. industries admit that they are willing and open to consider such a move. The stalemate ensues from the two not getting together.

For a very large part the fault may be directly attributed to the foreign parties themselves who would extend the invitation to U. S. business. The Yankee businessman has become notoriously omnipresent where he becomes involved in selling his goods on the foreign market in post World War II. The idea that he might jointly undertake the manufacture of his goods in a foreign country in partnership with local interests still is a new idea to the great many and regarded as heresy by not a few. There is one school of thought in the United States which is violently opposed to any migration of U. S. skills, capital, or industry where it will result in a reduced export of U. S. goods. However, members of this school of thought for the large part are exporters of consumer goods; and for one, the author feels that the majority of foreign countries should be as self-sufficient as possible in the manufacture of such goods. It has become almost axiomatic that the more industrialized countries are the best markets for our total exports. Where we may lose the sale of a million pairs of shoes to an area which develops its own leather and footwear industry, we gain many times over in the sale of other goods which the raised standards of living behind a population wearing shoes will demand of us. The same analogy is the basis for the establishment of new hydroelectric plants, steel mills, food-packing, textile plants, and the like.

In our survey several manufacturers expressed the feeling that the domestic market is becoming increasingly competitive and that possibly their greatest opportunity for expansion lay not so much in the development of new products but in establishing themselves in the foreign field. Thirty-six per cent of the manufacturers participating in the survey indicated that they were interested in expanding abroad; 17 per cent of those interested in expanding abroad revealed that they had been approached or voluntarily had contacted a foreign interest with a view to establishing a branch plant abroad or participating in the development of new manufacturing plants. Only 2 per cent of those who indicated that they were not interested in foreign expansion had been in touch with foreign groups regarding such a move.

U. S. GOVERNMENT SHOULD NOT OVERREACH ITS FOREIGN AID

Foreign countries, and the Latin Americas in particular, should undertake to correct any legal conditions which militate against the operation or movement of U. S. capital into their countries. They should undertake a realistic and concrete program of industrial public relations to "sell" a partnership of industrial private enterprise to U. S. business. The notion unfortunately prevails that the U. S. Government should generously extend the loans and other assistance needed for the development of industry in foreign countries. To a large extent this expectancy of largesse has stemmed from the open-handed philosophy of various federal agencies where the powers of international industrial development and promotion have been vested. Operating on the level of intergovernmental finance and international loaning and borrowing, their operations have overshadowed and in several instances stunted the growth of private enterprise. In certain quarters there is a growing opinion that the functions of these agencies overreach themselves at the expense of private enterprise. Unquestionably, their functions on such a scale as public works are justified. The ends accomplished by such loans are only possible on the government level and constitute an indispensable crutch to faltering or growing economies.

Many foreign countries offering a healthy climate to private enterprise have been slow to recognize and still slower to take advantage of the fact that their greatest help can be obtained directly from U. S. business and industry. As might be expected from certain quarters of the foreign press, such a move would be described as a new form of dollar imperialism, a plot to exploit the wealth of small and helpless countries by U. S. capitalists. An examination of how U. S. private enterprise operates in Venezuela, Mexico, and in almost any other part of the world today is a refutation of the charge.

The bitter but much-needed lesson, admittedly learned by the oil companies in Mexico, taught U. S. business as a whole a lesson it will never forget. The story of Mexican oil epitomizes the worst that can be described of American enterprise abroad. Unfortunately, it poisoned United States-Mexican relations for over a quarter of a century. On the one hand, it has stirred up a feeling of distrust throughout Latin America for U. S. capital, and on the other, it has instilled a fear of expropriation throughout U. S. business regarding foreign investment.

It is high time that these feelings were changed. Prospects for industrialization in Latin America will be interminably extended unless they employ the engineering knowledge, tradition of skills, and American capital available for the creation of new plants. They must offer a reasonable assurance of guaranteeing the rights and operations of U. S. capital in their country. A formula of co-operation must be arrived at which provides security, profit, and mutual responsibility.

President Harry S. Truman in his Inaugural Address has committed the United States to a "bold new program" of assisting other countries with our industrial know-how and capital investment. The job is one which must be principally intrusted to and accomplished through the channels of private enterprise, and justifiably so. In Truman's own words, "Our aim should be to help the free peoples of the world through their own efforts, to produce more food, more clothing, more materials for housing, and more mechanical power to lighten their burdens."

OPPORTUNITY *in the* COLLEGES

By W. J. KING

DIRECTOR, SIBLEY SCHOOL OF MECHANICAL ENGINEERING, CORNELL UNIVERSITY, ITHACA, N. Y. MEMBER ASME

AFTER a previous career of twenty years as an engineer in the industrial arena, the author is now completing his third academic year as a member of the faculty of the College of Engineering at a large eastern university. More than once during these latter three years, it has been borne in upon him that the average engineer, like many others in the "outside world," does not have an adequate conception of the opportunities and attractions of life on a college campus as a teacher of engineering science. It has become increasingly evident that there are, in fact, a number of popular misconceptions among laymen which tend to create a distorted view of the typical college professor and his world. The author harbored his share of these misconceptions for quite a few years and has often thought that he would have become interested in an academic post much earlier had he but known a little more about the matter. Hence, this presentation is inspired chiefly by a conviction that someone should tell the engineers of industry more of the actual facts of academic life—for their own sakes, as well as for the sake of engineering education and the larger interests of our common society.

ECONOMIC FACTORS

Of course, it is recognized generally that the basic motivations for an academic career are a native enthusiasm for teaching, and the satisfactions which come from helping young people effectively to develop their abilities, as well as from the opportunity to serve a cause and an institution commanding universal respect. To some teachers the intellectual rewards of scholarship and professional leadership are sufficient incentives; to others the academic life is the good life, here and now, which so many workers in other fields wistfully anticipate as the ultimate fruit of their labors. But it is not always appreciated that the economic factors may not necessarily offset these considerations.

Engineering-college faculty salaries are not always so low as many suppose. For example, the 1946 report of the EJC survey of the earnings of engineers[1] showed that the median base monthly salary of college or university teachers was about $400, twelve to fourteen years after graduation. This was almost identical with the figures given for the fields of construction, supervision, maintenance, operation and design, and only about $25 less than the corresponding medians for consulting, sales, and research. The comparable figure for administration-management (technical) was $490. Several large universities in the East, Middle West, and Far West have recently proposed or established salary scales providing minimum salaries of $3000 for instructors, $4000 for assistant professors, $5000 for associate professors and $6000 for full professors, for the standard 9-month academic year. Some schools offer appointments based upon 11 months employment per year at 11/9 of the foregoing rates. Many of the major colleges are fully prepared to pay from $6000 to $10,000 or more for outstanding teachers and department heads, and, by the same token, there are currently quite a few such teachers who are earning more than many chief engineers of industrial firms.

In addition to their regular salaries, college professors may earn substantial supplementary stipends, from consulting and research projects or by teaching in the supplementary 6 or 9-week summer sessions. Royalties from the sale of textbooks and the exploitation of patents may also provide appreciable increments of income. Some colleges allow their faculty to earn a full salary from an outside employer while on sabbatic leave with full or part pay from the college. Of course, many teachers make good use of the three months' summer vacation to augment their earnings while advancing their professional competence in an industrial position.

There are other compensations which often help to make the economic picture attractive. It is customary for children of faculty members to be exempted from the payment of tuition—which is now up to $600 per year in a number of first-rate schools. This item, together with additional savings due to residence near the campus, may easily amount to more than $1000 a year for each boy or girl in college—or a total savings (or value) of over 12,000 dollars for a family with three children. Most universities have a pension plan and offer group insurance on favorable terms. Leaves and allowances for illness are usually liberal in meritorious cases. To many persons the extra margin of security and peace of mind is an important consideration.

SECURITY AND FREEDOM

One sometimes hears of college faculties being disturbed by intrusions of state politics, but, by and large, the extra measure of job security is very appreciable, after a teacher has been granted "tenure" upon reaching the level of associate professor. Tenure means that an associate or full professor cannot be discharged or demoted until he reaches the age of retirement (usually 65 to 70) so long as he behaves with anything like normal decency. Gross misconduct or incompetence is, of course, not tolerated, but the typical professor with tenure is rather well protected from any material effects of administrative or political disfavor. This tradition of "academic freedom" is carefully sustained to insure the privilege of teaching or writing upon controversial subjects without fear of consequences.[2]

This principle of personal independence is generally extended to a rather broad area of professional activity, in respect to the senior faculty. A college professor is certainly much more of an autonomous individual than his counterpart among the engineers employed in industry. He is less accountable to "higher ups," freer to come and go as he pleases, to plan his own work and to carry out his program with a minimum of administrative sanction.

TEACHING LOADS AND OFFICE HOURS

In most colleges the normal "business hours" are from 8:00 a.m. to 5:00 p.m. (with an hour for lunch) Monday through Friday, and from 8:00 a.m. to 1:00 p.m. on Saturday, extending roughly from September 15 to June 15.

There are apt to be a number of holidays and four-day week-ends (as at Thanksgiving and Easter), capped by a two-week vacation at Christmas. As a rule the members of the teaching staff are not expected to be on duty throughout the regular

[1] "The Engineering Profession in Transition," published by Engineers Joint Council, 33 West 39th Street, New York, N. Y., 1946.

[2] The extraordinary case of the professors recently discharged from the University of Washington, for alleged Communist activities emphasizes the current fear of Communism as a threat to all forms of liberty, including the academic variety.

business hours. A representative working schedule would include perhaps 12 to 16 "contact" hours per week in classroom or laboratory plus 3 to 6 regular office hours for consultation with students. The contact hours might be reduced to 8 or 9 for a man doing considerable administrative or research work, or might be increased to 18 or 20 if the teaching load is largely routine laboratory or drafting-room supervision. Although the professors are quick to point out that they may average 40 or 50 hours per week when the time required for preparing lectures, grading papers, and serving on committees is added to these regular duties, the fact remains that few of them are required to be on the campus as much as 24 hours per week while classes are in session.

It is not uncommon for a teaching schedule to include no classes earlier than 9:00 or 10:00 a.m. with all day Tuesday and Thursday off, or with two afternoons and two mornings off every week. This is not to belittle or to underestimate the long hours of study and service that most teachers devote to their assignments—many of them work much harder than their less-inspired brethren in other fields of engineering. But it is nevertheless quite convenient, on occasions, to have the privilege of taking an hour or a day off for personal affairs without notice, even if it is counterbalanced by extra work at home or in committee meetings lasting late into the evening. It is also true that generally a professor can set his own pace, to agree with his ambition, health, or temperament.

The atmosphere and the tempo of a university are intended to be leisurely, quiet, and free from the high pressures and tensions of industry, to be conducive to scholarly pursuits. These privileges and prerogatives are not often abused—and are even less frequently abused with impunity in respect to remuneration and advancement.

LEAVES AND VACATIONS

As previously mentioned, leaves with full or part pay for illness and personal business of various kinds are usually liberal. Many engineering schools grant regular "sabbatic" leaves to all professors after each six years of service—allowing the option of a full year at half pay or one academic term ($4\frac{1}{2}$ months) at full pay. It is expected that this time will be devoted to improvement of professional competence, as by travel, visits and studies in the field, industrial employment, or preparation of material for textbooks. Thus including the regular summer vacation, the professor can, if he wishes, spend something over seven months away from the campus every seventh year without loss of his regular income. In addition, each year he is privileged to spend three full months (whenever he feels that he can afford it) on a vacation which allows him to take his family on a leisurely tour of the country, or abroad. True, not many professors spend every summer touring or sunning themselves on the beaches—they frequently have more interesting and profitable things to do—but at least they are free to invest their time as they choose.

In respect to other leaves for extended periods, for government service, industrial experience, or to take advantage of "exchange professorships" in other institutions, the colleges are likewise quite liberal.

ATMOSPHERE AND ENVIRONMENT

Among the pleasant features of college life is the special quality of the atmosphere which pervades and surrounds the typical campus. The physical setting is characteristically pleasant, clean, and quiet—frequently in a delightful countryside or suburban residential area. The beautiful lawns, trees, and gardens, the fine old buildings steeped in tradition, and the architectural classics of the "quadrangles" can inspire even a prosaic engineer with an enduring enthusiasm for the intellectual and aesthetic adventures which are open to him in these dedicated halls of learning.

There is, however, little of the "ivory tower" isolation in the professional activities of the engineering departments. Industrial representatives visit the campus every week, to interview prospective employees, to give "nonresident" lectures, to discuss research projects or to consult experts in various fields. Many conferences, symposia, and special courses draw visitors from other universities as well as from industry and government agencies. Likewise, members of the engineering faculty participate in many professional activities in the field, in the big cities, and abroad.

On the campus itself the professor's contacts are mostly with young people—clean-cut, stimulating, and refreshing young people. Almost all of his associations with his faculty colleagues are cordial, pleasant, and interesting. There are many scholars, enthusiasts, philosophers, artists, scientists, idealists, engineers, practical men of affairs—predominantly gentlemen in the best sense of the term.

Among the extra dividends of life in a great university are the cultural feasts spread so abundantly before the faculties. There is a great variety of lectures by distinguished scholars and authorites in every imaginable field, from all parts of the world. Even the Sunday morning services in the Chapel are apt to be conducted by outstanding preachers and theologians—a different one each week—who come by invitation from far and near. There is a constant succession of art exhibits, symposia, debates, plays, demonstrations, concerts, and shows, most of them free or at nominal cost and all of them conveniently at hand and accessible.

The formal and informal social life of the campus is likewise varied and active. There are receptions, inaugurations, dedications, and celebrations, as well as a pleasant variety of faculty and student-faculty parties, smokers, and dances.

Then, of course, there are the college sports activities, for those who like that sort of thing. Middle-aged ex-engineers who have lost all interest in football and basketball will commonly change into enthusiastic fans after joining the faculty of a university and getting acquainted with the teams. Practically all of them become more interesting when one has a vested interest in the players and the institution which they represent. It is also convenient for the faculty to participate in such sports as golf, tennis, swimming, volleyball, handball, badminton, etc., using college facilities.

PROFESSIONAL DEVELOPMENT

Professional development of faculty members is a matter of especial interest to engineering colleges. It is aided and abetted by many of the factors mentioned, as a by-product of campus life. In addition, most schools encourage and support participation in professional societies—local and national—and in basic and applied research. Many engineering departments conduct regular seminars for the edification of their faculty and graduate students in their special fields. Young instructors are encouraged to become candidates for advanced degrees. Publication of first-rate technical papers and their presentation before the major engineering societies are considered especially worthy activities since they reflect credit upon the college as well as the individual author. The colleges are not inhibited in this respect by competitive restrictions—on the contrary, they usually insist that the results of all research and special studies sponsored by any agency shall be freely published. In general, it is the ambition of engineering colleges to develop their professors to the highest attainable level of scholarly achievement and professional prestige, since their major investments are in individuals rather than in products.

As a matter of fact, engineering educators as a group, by the

very nature of their work, are motivated toward the professional ideal, as delineated so ably by the late Wm. E. Wickenden in his classic address "The Second Mile." They are actively concerned with three principal enterprises: (1) The advancement of their particular areas of engineering science; (2) improvement of the art of engineering education and, (3) advancement of the profession of engineering and the contributions of engineers, individually and collectively, to the welfare of humanity. These are luxuries which most businesses simply cannot afford, as immediate objectives.

The zeal and enthusiasm with which representative educators pursue these objectives is striking. The author's eyes were frankly opened when he attended his first annual meeting of the American Society for Engineering Education (formerly the SPEE) in 1946 at St. Louis. The sessions ran a full week, morning, noon, and night, through Saturday and Sunday, with more spirit and interest than could normally be distilled out of a half-dozen meetings of the founder societies! These people are really devoted to a cause, or causes, which they believe in. It appears that their enthusiasm is sustained and whetted by the fact that their causes are anything but forlorn; they have much tangible evidence of accomplishment and their art is constantly changing, developing, and growing at a healthy rate. In many quarters this attitude carries over between conventions, in the activities of the various faculty committees which address themselves to the development of curricula, techniques, and practices on the individual campuses.

FUTURE PROSPECTS OF THE COLLEGES

At the present juncture the whole field of higher education is flourishing and expanding on an impressive scale. Authoritative surveys have indicated that college enrollments, which are now in the neighborhood of two and a quarter million, should double within the next ten years. Engineering-college research amounts to hundreds of millions of dollars annually and is growing to formidable proportions. Public appreciation and support of higher education has reached a new high and appears to be firmly established. A college degree has become almost universally an indispensable prerequisite for securing the better jobs in business, industry, and the professions. To provide for the anticipated growth, the President's Commission on Higher Education[3] recommends that the total national investment in university and college plant be increased from the 1947 level of four billion to nearly thirteen billion dollars by 1960. Along with this the Commission recommends an increase in faculty from 155,000 to 350,000 and in annual operating expenditures from one billion to two and a half billion dollars, over this same period. Even if these goals are not fully attained, it is clear that higher education is entering into a period of striking and healthy development.

All of this means that there will be a great variety of exceptionally fine opportunities for engineers qualified for teaching or research positions in the colleges, for many years to come. There is currently a chronic shortage of first-rate men with a sincere interest in teaching, combined with adequate technical competence, professional experience, intellectual curiosity, and broad social consciousness. The ideal attributes of college faculty personnel are admirably delineated in the report of the President's Commission.[3] The greatest demand and the greatest opportunity is for the genuine scholar with a lively enthusiasm for his subject and the ability to impart that enthusiasm to students and fellow engineers. Along with this, there are tremendous opportunities for participation in the vigorous development of engineering education, now entering a new phase of co-operation with industry, Government, and society.

All three of these groups have come to a new appreciation of the formidable role and effectiveness of present-day engineering science in the competitive arenas of national and international affairs. Just as the new fields of Industrial and Administrative Engineering were introduced into the educational world around the turn of the century, so now—at the half-way mark—Human Engineering and Social Engineering are the vital new challenges to the colleges. While the physical sciences have lost none of their enormous significance and prestige, the social sciences are coming into their own as the keys to the crucial problems of our times. Engineers can play vital roles in bringing social progress more nearly into line with the monstrous technological salient by applying their intellectual disciplines and the spirit and tools of science where the hard-boiled businessman, the politician, and the mystic have failed after so many generations.

The obvious fact of the matter is that our industry, our science, our engineering, or our "way of life" can be no better than the vision and training of our people; and for several generations our colleges and similar institutions of higher education have been by far the most effective agencies for enlarging the vision and advancing the training of our leaders in these categories. In fact it is the function of the colleges—not always perfectly performed—to serve as repositories, sources, and clearing houses for the arts, the sciences, the experience, and the wisdom of our society. Other agencies, of course, contribute in various ways, and it is doubtless true that we will continue to advance whether the colleges prosper or wane; but it can hardly be denied that no other agency in the contemporary scene is in a position to set the pace of our advance on all fronts in such a decisive manner.

The significant fact here is that, although the colleges have done much, they could do a great deal more to accelerate the pace of our sociological progress if they were subsidized and supported more effectively—purely as a realistic investment in our industrial and national interests. This is by no means simply a matter of financial support, although this is a major factor. There is the important matter of psychological, moral, or social support, with particular reference to the prestige and professional status of the college professor in our present-day sociology, in this country.

In Europe and South America the professor is still, usually, the outstanding man in his field—there being no better place to exploit the talents of such a man. In America the professor is sometimes pre-eminent, but all too often the key men are lured into industry, business, or elsewhere. Most frequently the inducements are financial, but it is clear, to the author at least, that in many instances a valuable man is lost to the academic world simply because he does not realize that there are many tremendously satisfying compensations, privileges, and opportunities in the colleges of today. It is indeed a privilege to be identified with one of these great institutions, to serve its worthy causes, to design and build the engineers who will design and build our better world of tomorrow, and to enjoy the delightful associations of the major campuses. We must do more to bring these opportunities to the attention of our best engineers—for the same reason that prompts the farmer to save his best corn for planting—instead of allowing so many of them to be "wasted" or "consumed" in the more restricted and transient enterprises of the world of today. We must help these engineers to appreciate the full implications of Elihu Root's words when he said:

"The general, the statesman, the man of affairs all pass away and are forgotten, but to have builded oneself into the structure of an undying institution, to have aided the development of these priceless agencies of civilization, is to have lived not in vain, but is to have lived in perpetuity."

[3] "Higher Education for American Democracy" (in 6 small volumes), a report of the President's Commission on Higher Education, U. S. Government Printing Office, Washington, D. C. December, 1947.

INDUSTRIAL RESEARCH

By A. G. CHRISTIE

THE JOHNS HOPKINS UNIVERSITY, BALTIMORE, MD. HONORARY MEMBER ASME

RESEARCH has either been the beginning of or has had a leading part in the development of every modern industry. New processes, new machines, new materials, and new applications of these materials have been developed through research. Under present conditions, an industry can thrive and develop only through such discoveries and their applications. The future welfare of the industries of York is closely connected with further developments of their products through research. How and where can this research be carried out to best advantage and at lowest cost?

WHAT IS RESEARCH?

Let us consider first what is understood by this term "research" and how research is carried on. Popular writers make it appear that the results of research are the works of genius. Many developments according to these authors are the result of a flash of inspiration or imagination on the part of the person who conducts research. Nothing is said of the long step-by-step search for the desired solution of the problem nor of the many persons who may have contributed time, thought, and effort toward the final result.

It has been said that the day of the experimenter in an attic is past. Research today requires a full knowledge of past achievements in contingent lines and the joint efforts of many people in a fully equipped laboratory to find the desired answer.

PURE AND APPLIED RESEARCH

One must appreciate the distinction between pure and applied research. In the former the scientist searches out new truths of nature and of the elements that occur on this earth. He is not interested in the practical application of these truths. He seeks to satisfy a natural curiosity. He follows up any idea that attracts his fancy. These scientists are our great explorers. They open up new territories of knowledge. One may take as an example of such pure science now in the public eye the discovery of Lord Rutherford and his associates of the possibility of splitting the atom.

Industrial research is concerned with the exploration and development of the new territories opened up by the pure scientist. The searches are generally undertaken with definite objectives in view. While there is the same urge to learn truth regarding the subjects treated, in general the object of industrial research is to find something in the new territory of science or even to work over old territory, which something will be of use and benefit to mankind and which will yield a profit to the concern which has financed this industrial research. This application of industrial research lies in the field of engineering and hence we, as engineers, should be keenly interested in the methods and procedures of industrial research. The engineer's place in reference to the pure scientist is best stated in the words of an automobile garage advertisement in Baltimore, "When you stop, we start."

Let me illustrate industrial research by an example from my own experience. In 1909 the late Carl C. Thomas asked me to direct a research in the laboratories of the University of Wisconsin. Thomas had carried out a research project at Cornell University on the specific heat of superheated steam. This study gave him the idea of an electric steam meter and work was undertaken by a team of engineers on this development. The basis of the study was simple. The quantity of heat added to a given weight of substance is the product of its specific heat and the rise in temperature, the determination of both of which can be made by well-known methods discovered by physicists. Conversely, if the quantity of heat added to a mass flow, the specific heat, and the temperature rise are known, the weight flowing can be determined. The measurement of the quantity of heat can be made an accurate measure of flow. Endless difficulties cropped up in metering steam due to moisture. Thomas suggested that the apparatus which had been developed, be tested with air which had no moisture difficulties. The first crude apparatus gave excellent results. The work on steam was dropped and the Thomas electric gas meter was developed. This meter is widely used in gas service, both here and abroad.

In general the engineer realizes a need and then studies the results of pure science to find by research a means to satisfy this need.

Sir Richard Gregory in his book on "Discovery" says, regarding the industrial investigator:

> The research which he undertakes or organizes has for its object the artificial preparation of substances which are naturally rare, the production of a new process or the improvement of an old, the design of machines which will increase his power over nature and of instruments which will enable him to laugh at limitations of time and space.

METHODS OF RESEARCH

There are two methods of carrying out an industrial research. Assuming that one knows what is being sought, one can follow the Edisonian method of trying everything that might relate in any way to the object of research and noting results. This requires keen observation and analysis, endless patience, and ability to use common sense and reasoning in making correct deductions from results. The proper solution may be found but at the expense of much time and money. Often this method leads to a discovery or invention of high value. Mr. Edison's well-known search for a filament for the incandescent lamp is one of the best examples of this method of research.

The classical method proceeds along more scientific lines and is one now generally pursued in first-class research establishments. When a certain need or objective is formulated, a theory is developed by thoughtful analysis and study of facts already known. The experimenter then proceeds to test this theory in the laboratory and by analysis of data and modification of theory as a result of tests, leads to further tests and finally to a solution of the problem. An example of this method of research was Midgley's research leading to the production of the Freon refrigerants based on fluorinated hydrocarbons. He reasoned from known physical and chemical data that the substances which would possess the desired refrigerating properties would be one of the fluorine compounds and then proceeded to find the proper one.

Industrial research in general combines both of these methods. Analysis of the problem indicates a certain area of knowledge wherein the answer may lie. Edisonian methods may be applied to find the answer in that limited area.

Presented at a meeting, York, Pa., March 14, 1949, of the Susquehanna Section of The American Society of Mechanical Engineers.

It will be apparent that thought is an important contributing factor in research. In fact it is one of the most important elements. Few great inventions are the result of a flash of genius. Rather they are the result of long careful consideration of the particular problem and are the final climax of this analytical thought. Take for instance, Watt's invention of the separate condenser for the steam engine. He had been working for a long period on a Newcomen engine where the steam was condensed within the cylinder and had endeavored to discover how to improve engine performance. He had given much thought to this problem and then one day when walking in a park, the idea suddenly occurred to him to try a separate condenser outside of the engine. His thought processes over a considerable period of time had led him to the final solution.

In order, then, to pursue industrial research one should learn all facts related to the problem, analyze and digest these, then try those solutions which appear to have promise. Again, analyze results and repeat until the final solution is accomplished.

PROCESS RESEARCH

Industrial research can be divided into two classes; process and product. Process research is concerned with the development of a new process for the production of a commercial article. Competition frequently forces industries to review their manufacturing methods and to determine whether products can be had by new processes at less cost. Many examples could be cited of this type of research. The scarcity of tin during the war led to the development of a tin-electroplating process in place o the old dip process thus saving much tin and securing a superior product. Another example is the use of the contact chamber for sulphuric acid manufacture in place of the older Glover tower method.

The first step in process research is to outline the general problem. Next a survey of literature is made to collect all relevant facts. The best method of attack is then outlined, the needed data determined, methods selected, and an experimental program outlined. The subsequent experimental data are sifted and analyzed. Indicated leads are followed up and deductions made. Finally, an improved process results.

Equipment research conforms to the same general methods. Here the object is to develop a better machine to carry out some processes. Competition is a factor in this case and the new machine should have characteristics radically different from competing machines on which there may be patents. Many examples of this type of research can be found in the machine-tool industry and in the equipment used to make automobiles.

PRODUCT RESEARCH

Product research promises to be one of the most extensive fields of industrial research. The development of new products by synthetic methods, the utilization of waste products from industry, and the improvement of present articles of trade afford an increasing field for profitable research.

Kileffer in his book, "The Genius of Industrial Research," lists three types of product research. The first is a product with no market, such as a residue of a process which appears to have no market value at the moment. For instance, before the war the Quaker Oats Company, in searching for an economic use of oat hulls from the production of oatmeal, found that these contained furfural. A process was developed for its recovery and little use was found for it until the synthetic-rubber process developed during the war. It was then found to be a selective solvent for butane in the process of producing butadiene. The demand for furfural was so great that a large plant was built at Memphis to recover it from cotton-seed hulls, corn cobs, or other vegetable wastes.

The second case quoted is a market and no product. During the war many commercial products from abroad were cut off. The demand for these still persisted. New products had to be developed to meet this demand. For instance, certain China oils used in the production of electrical insulation were unobtainable when Japan seized China. Research developed new substitutes from resources at hand which took the place of these imported oils.

The third class is no market and no product. Someone conceives the idea that some new substance may be produced but there is no demand for it and a market must be created. Research on such a material requires great faith on the part of management as to ultimate financial results. As an example of this research one might refer to the nitrocellulose solvents that were left over at the end of World War I. To get rid of these, research work was started on new products. This resulted in the development of the quick-drying lacquers with a nitrocellulose base that are now used for painting automobiles and for other purposes. But a market had to be created for these products.

RESEARCH FACILITIES

Many large industries have established industrial research organizations from which one may expect great results in future years. Products of such laboratories are already displacing older commodities in today's markets, such as nylons for cottons and silks, plastics for woods and porcelains, detergents for soaps, and synthetics for natural rubber.

These facilities are costly and must be staffed by a group of experts. It has been said that such companies must devote from 1 to 3 per cent of their gross sales to maintain an aggressive research establishment. On the other hand the financial returns may be large. For instance, it is said that Standard Oil of New Jersey has had a return in excess of fifteen dollars in profits for every dollar spent on research. Others have had similar profitable experiences. Large organizations are forced to do research work to maintain their competitive positions.

One will ask how the smaller industries can foster research that will maintain them in favorable competitive positions. Certain small industries such as garages, jobbing machine shops, certain woodworking establishments, and the like, are of the service type. While improvements may be made in processes, machines, materials, and commercial practices, in general these industries have limited interest in research. In many cases, little or no engineering services are required either in establishing the industry or in its operations.

Many small businesses make a product for sale in competition with products of other concerns among which may be the large concerns with research laboratories. New articles are continually appearing on the market which tend to displace older products. The small industry must be keenly alive to these trends, for unless it can maintain its market, it soon ceases to be profitable. While many executives realize the need of development in their industry and of research to attain this end, they are deterred from action by fear of high costs and by lack of knowledge of how this research may be carried out.

The January 6, 1949, issue of *Iron Age* contains an article on research in which the question is asked whether the increasing cost of research is preventing small and medium-sized plants from participating in and enjoying the benefits of development work. Data on costs are presented and gains noted. Quoting from the article:

> To return to the problem of the small company in setting up a (research) program, three things are essential: (1) It must keep up with the operating practices of its own and other industries; (2) it must periodically consider its own products, operations, and position and weigh against these the possible advantages to be derived from specific

research projects; (3) it must have at its service the facilities and experience of a well-organized research laboratory.

The first two of these requisites usually can be handled and usually are best handled by some individual within the company. Where there is no one with the time or background of experience to properly handle the job, the services of a consultant familiar with the field can be obtained. Research personnel and laboratory facilities, the third requisite, can be furnished by research laboratories, nonprofit institutes, or universities.

Granted that industrial research is needed in small industries, should it be conducted wholly in the industry itself, jointly with some trade association, or by some research organization? Actually, it has been done in all three ways. When done in an industrial plant, it often takes a long time to complete, is quite expensive, and may lead to complicated processes due to lack of experience of the small research staff.

For instance, before the war an inventor was engaged by a lime company to develop a process that he had invented to produce pure magnesium carbonate from dolomite. Test-tube results were satisfactory. However, the inventor had little experience with the large-scale equipment required in the process and expensive mistakes were made in the plant design which delayed the operation of the process.

A concern which develops a new product or process through its own research generally can be the sole possessor of any advantages that accrue from this development. On the other hand developments from research of a trade association are the joint property of all members of the association. All can enjoy the advantages of any new discovery. No special competitive advantage accrues to any one member. However, some excellent research has been done by such trade groups as the Portland Cement Association, the Pulp and Paper Institute, and the Gas Industry.

Small concerns have access to many research organizations for solution of their problems. Among the larger research laboratories, might be mentioned Battelle Memorial Institute, Columbus, Ohio, Arthur D. Little, Inc., Cambridge, Mass., and the Electrical Testing Laboratories, New York, N. Y., Research institutes have been organized during recent years in connection with engineering schools such as the Armour Research Institute of the Illinois Institute of Technology, the Research Laboratories of the University of Michigan, and the Institute of Cooperative Research at The Johns Hopkins University. These institutions operate in general on a nonprofit basis with a full-time staff of research men and technicians and with ample facilities to attack various problems. Contact with the university instructional staff, its laboratories, and libraries, keep the research men in touch with all new developments both in laboratory techniques and in new theories.

Commercial research laboratories have various scales of charges for their services. The nonprofit research institutions charge for direct labor and material plus an agreed-upon rate for overhead to cover the indirect costs of operation. Contracts cover the duration of the research, the ownership of research equipment especially purchased for the project, titles to inventions, and compensation, if any, to individual patentees.

As an example of the type of investigation that can be handled by a research staff, the following is cited. The head of a large dairy came to the University with the problem that about one milk bottle in every ten had to be discarded each day due to chipping or breaking. Bottles from several sources seemed equally brittle. Nothing in the dairy plant or in its handling or bottling process seemed at fault nor were delivery men responsible. A research was started to determine the cause of this loss of bottles and it extended over a considerable period before a satisfactory solution was found. The glass constituents were first studied and found satisfactory. Mechanical tests were then applied. These led to a critical examination of bottle design. The bottles were basically die castings and were made with varying thicknesses in parts and with some sharp corners—a thing to be avoided in a casting. The problem was solved by a redesign of the bottle dies and some changes in the method of manufacture. The resultant saving to the dairy paid for the cost of research in a few months. The results were later divulged to the whole dairy industry and have governed bottle production since that time.

Another example is the weightometer widely used by road inspectors to check loads on vehicles. A man of inventive turn of mind woke one night during a slight illness to find himself lying on a hot-water bottle. He reasoned that the pressure in the rubber bottle must have been a measure of the weight upon it. A small industry built a cylinder to hold the round water bottle with a piston to fit above it and arranged for further test and development at the University. Tests confirmed the inventor's deduction. Metallic parts were finally developed in place of the rubber bottle and a valuable commercial article resulted.

Other similar examples may be cited, but these suffice to show what can be expected.

ORIGIN OF IDEAS

Researches in product development may be instigated by suggestions from production men, salesmen, and designing engineers. While these ideas may be original, they generally follow along traditional lines although much time and money may be spent in their development.

Mention has been made of the origin of new ideas in the minds of inventors. These men have contributed enormously to our progress.

Often the need for a new useful product arises from the forced necessity of disposing of an industrial waste. For instance, the Marathon Paper Co., of Wisconsin, dumped the slop from its sulphite digesters into the river. The liquor in this waste absorbed oxygen and killed fish. The company was restrained by the Government from dumping this raw material and was forced to find some method of disposing of the offending liquor. The method developed left a brown wet sludge for which there was no obvious use. The late Guy Howard was engaged to develop some useful product. He found several of much promise and others for which no use has been found, so far. One of the useful and profitable by-products is "Vanillin," which is now a leading article in domestic trade.

Atomic energy has many intriguing angles. Much research remains to be done to develop protection against radioactivity, to find how this activity can be used in the arts, and to develop by the use of radioactive materials entirely new products and processes.

How can a mechanical engineer sell his executives on a research project? Procedure will naturally vary in individual cases. Let the engineer approach this question in an engineering manner. First, the basic idea upon which research seems advisable should be carefully analyzed. What work has been done by others along this line? What were their results as far as can be determined? Is the basic theory of the idea correct? Where can the research be carried out most expeditiously? Who is best fitted to direct this work? What equipment and staff will be needed? How long may it take and what will it cost? Finally, what estimate can be made of the economic values of the product of this research to the firm which promotes it?

These are questions the management will ask. The engineer should prepare a memorandum covering them to the best of his ability. Having thought his problem through in a compre-

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MEDICINE *and* ENGINEERING *in* SUBMARINES

By T. L. WILLMON

CAPTAIN, MC, U. S. N. MEDICAL RESEARCH LABORATORY, U. S. NAVAL SUBMARINE BASE, NEW LONDON, CONN.

HISTORICAL

THE history of the modern submarine begins about 1624, in the time of James I of England, when a Hollander, Cornelius von Drebbel, constructed a wooden shell covered with goat skins, powered by 12 oarsmen, which successfully made a submergence to 15 ft with the august personage of James I aboard.

In 1772 David Bushnell, a Yale student, built a submarine craft called the *Turtle*. Not much bigger than a barrel and of much the same shape, it was operated by one man, who in a sitting position turned a crank connected to a screw propeller. The *Turtle* carried a bomb outside the hull. His unsuccessful attack in 1777, on the British flagship *Eagle* anchored off Staten Island was the first recorded use of a submarine in actual warfare.

A Connecticut engineer, Robert Fulton, was able to interest Napoleon in the construction of an undersea craft to destroy the British fleet, but eventually Napoleon became discouraged and Fulton then took his ideas to the British. The First Lord of the Admiralty, after lengthy discussion, was of the opinion that the submarine should not be encouraged, for with its development it would be adopted by other nations to the hazard of the British fleet, so Fulton returned to Connecticut and invented the steamboat.

During the war between the states, the Confederate Navy built several *Little Davids*, which were iron hulls, steam-driven, not completely submersible, but ran with decks awash. These were fitted with a spar-type torpedo. One of the *Little Davids* successfully sank a Federal ship, but was herself demolished.

Working in New Haven in 1877, J. P. Holland and later Simon Lake, also of Connecticut, entered the field and were largely instrumental in developing the prototype of the current submarine, which was being developed concurrently in Germany. The present submarine is essentially a refinement and enlargement of the submarine for 30 years ago, developed in the period 1905–1918. It exceeds in many ways the operational fantasies of Jules Verne.

Many engineering developments have been largely the result of submarine requirements. The lead-acid storage battery received great impetus as did the Diesel engine, which was developed for safety and to enable burning of a less highly refined and cheaper grade of fuel.

WHERE THE MEDICAL OFFICER COMES IN

When the boys began their peregrinations beneath the surface, closing themselves away from normal atmosphere, they began to run into problems. Consequently, from the early days there have been a few doctors who have become involved in submarining in attempting to solve some of the problems and protect personnel against the gadgetry of the engineers.

The relatively few medical personnel who became interested in pursuing these lines of endeavor are commonly "Dr. Jekyll and Mr. Hyde" individuals, torn between a career of medicine, for which they are trained, and engineering in which they also are interested. They receive the line officers' course of instruction and become qualified in deep-sea diving, followed by the six-month course in the Submarine School. A sufficient portion of this period is spent in the Medical Research Laboratory, Submarine Base, to enable us to give them the advantage of our experience and to indoctrinate them in techniques and methodology.

As is well known, a submarine is a cigar-shaped craft the length of a football field, divided into nine watertight compartments, powered for surface cruising by Diesel-electric drive, and for submerged running by electric motors powered from storage batteries. Submergence is effected by flooding ballast tanks from the sea to destroy positive buoyancy. Ventilation on the surface is effected through air-induction lines leading from the conning tower. Upon submergence, the air contained in the hull is recirculated and is cooled and dehumidified by refrigeration units. As necessary, air may be revitalized by bleeding oxygen into the ship and absorbing carbon dioxide. Contrary to common belief, only a negligible increase in pressure is experienced within the submarine during a normal dive.

MEDICAL PROBLEMS OF THE SUBMARINE

Our submarine medical problems include those of the past which are now augmented by improved tactics, equipment, and construction enabling deeper submergence, greater submerged speeds, and more prolonged effectiveness of the weapon.

The atmosphere of the submarine has always required study and control, not only regarding oxygen content, but also for noxious gases and fumes, including hydrogen from the storage batteries, chlorine generated by salt water gaining access to the sulphuric acid of the storage batteries, and carbon-dioxide content of the atmosphere inherent to long submergence. Coincident with long submergence in, or even surface operation in tropical waters, temperature and humidity control within the submarine were found to be mandatory. Prior to air conditioning, 10-day patrols reached the absolute limit of human endurance. During the war, 60-day patrols were not unusual. The air conditioning not only enabled personnel to tolerate these extended cruises, but also protected delicate electrical and electronic gear. This accounted in a considerable degree for the stamina of our craft in contrast to the submarines of other navies not so equipped.

DEVELOPMENT OF THE SNORKEL AND PHYSIOLOGICAL EFFECTS OF ITS OPERATION

Duration of submerged running was limited by the battery capacity in our wartime submarine. In order to prolong submerged operation, the snorkeling device was developed. The snorkel is a rigid, streamlined, retractable housing containing two air conduits sufficiently large to supply intake air

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and serve as engine exhaust, thus enabling the submarine to operate on engines while submerged. The length of the snorkel is sufficient to enable the submarine to run at periscope depth. The top of the snorkel is fitted with a water-closing valve which is actuated when the snorkel head becomes awash through loss of depth control or advance of seas. Since the engines continue to function and draw air from the boat, this closure causes a reduced pressure to be induced within the submarine to the point that a switch is automatically activated to stop the engines. In a seaway there may be a continuous and rapid fluctuation of ambient pressure induced by frequent closures of the head valve.

In snorkeling, then, submariners physiologically have become aviators. A slightly decreased pressure is present in the boat during all snorkeling. Upon sudden closure of the snorkel head valve, the physiological altitude within the submarine rapidly increases, so that personnel are subjected to a rarified atmosphere reaching the order of 7000 ft altitude. Upon surfacing and reopening of the head valve, air at atmospheric pressure flows into the boat at a rate comparable to a vertical dive of about 7000 fpm.

The significance of these factors is concerned with the middle ear and sinuses which are cavities closed to the ambient atmosphere except for small openings—the ostia of the sinuses and the Eustachian tube from the middle ear. These cavities normally ventilate with changes of ambient pressure. The sinus ostia may be blocked by infection. The Eustachian tube of the diameter of a small pencil lead is normally collapsed but becomes patent in pharyngeal muscle movement of swallowing, yawning, or in blowing the nose. Should opening not occur incident to an increase of atmospheric pressure, a pressure differential on the two sides of the ear drum, or within the sinus, results. The negative pressure in the cavity is productive of severe pain and of tissue damage if the pressure differential be marked.

Consequently, the fluctuation of pressure induced by snorkeling requires patency of sinus ostia and continuous opening of the Eustachian tubes to compensate pressure in the middle ear and sinuses. Although selective screening of submarine personnel includes ability to compensate for increased pressure, a majority of individuals experience difficulty from time to time in clearing ears and sinuses. With continuous snorkeling, the problem becomes more acute inasmuch as this is a voluntary process not effected during sleep.

An adequate evaluation of the seriousness of this problem must await more prolonged periods of snorkel operation. This work is currently in progress. Findings to date have been of less magnitude than originally anticipated.

Due to the relatively small volume of air contained in the engine room, it is not operationally feasible to limit the snorkel-induced fluctuation of pressure to that space. However, fluctuation-free sanctuaries may be necessary in portions of the ship for use of sleeping personnel and those temporarily experiencing inability to compensate for pressure variations.

Research and therapeutic use of radium applications to adenoid tissue of the nasopharynx have been carried on since 1944, in the Medical Research Laboratory, New London. This procedure gives promise of prophylaxis or salvage of over 85 per cent of those submariners unable to compensate for pressure fluctuation.

PROTECTIVE CLOTHING

Topside watch-standers on submarines have always been wet in inclement weather. In rough seas and cold weather their physical tolerance has often been limited to 30 min. Spray is commonplace; green seas, waist-deep, not unusual.

Concurrent to a streamlining of our new high-underwater-speed snorkel craft which we call *Guppies*, the submarine bridge is wetter and colder than ever. Based on the belief that it is much better to get wet and cold all at once, one of our submarine skippers aptly stated that the proper way to have a man stand a watch on a *Guppy* immediately upon his reporting topside, is to tie a line around his waist, throw him over the side, haul him back aboard, stand him up, and say, "O.K. now stand your watch."

For dryness, something comparable to a diving suit is required. Efforts have been directed toward the development of waterproof and warm clothing, without bulk, easily dried, and economically stowed.

Working in conjunction with the Bureau of Supplies and Accounts, several experimental suits have been tested at sea during the past year, culminating in a contract for 500 of the resultant prototype for large-scale testing now in progress. The current model is a one-piece, nylon, neoprene-coated, hooded, coverall type of garment, with boots attached. The hood is designed separately from the garment with a waist-length inflatable skirt, to produce a Mae West type life preserver. This suit, built large, and worn over warm woolen clothing, is found to be comfortable in cold wet weather. For extreme cold a study is being made of an electrically heated undersuit.

"PROJECT RAINBOW"

With the new snorkel submarine, the craft may remain submerged for days on end, having only the snorkel tube protruding to the surface. There is no difference between night and day. Operations become vastly more routine and monotonous to the point that boredom may intervene to the detriment of morale. One of the efforts to combat this factor we call "Operation Rainbow," consisting of color and light conditioning of the submarine's interior to effect a change of pace on walking from one compartment to another, creating illusions of greater space and depth to the interior, and incorporation of adequate yet pleasant, nonglare lighting. The submarine heretofore has been coldly operational and utilitarian. Experimental results to date are most encouraging regarding reaction of personnel. The attempt is to attain the ultimate of habitability within the limitations imposed by operational requirements.

SUBMARINE ESCAPE AND RESCUE

One of the hazards of submarine operations is accidental flooding of the hull to a degree that positive buoyancy cannot be attained by blowing ballast. This occurred in the *Squalus* disaster in 1939.

If the depth of the water is such that the hull is not crushed, it is likely that a considerable portion of the crew will be safe within the ship.

Two plans are in vogue for saving the crew. One is the submarine-escape apparatus, commonly known as the "lung," which is a rubber bag, equipped with a mouthpiece and carbon-dioxide absorbent, so that oxygen may be breathed while floating to the surface. The second is the rescue chamber which requires that a diver attach a downhaul cable to a hatch of the disabled submarine, following which the 9-ton pear-shaped chamber pulls itself down and forms a seal over the hatch, which is then opened to remove the submarine's occupants for delivery to the surface. This method was employed on the *Squalus* at 240 ft for removal of 33 men.

With stronger hull construction, deeper submergence becomes possible and submarine crews may be entombed safely within a disabled submarine under conditions not feasible for deep-sea-diving operations. Experiments are under way to develop measures enabling a disabled submarine to release a buoy

which will surface the cable for hauling down the rescue chamber, obviating the necessity of employing a diver.

Submarine escape by the breathing device, or "lung," has depth limitations due (1) to oxygen toxicity under increased pressure, if oxygen be used as the respiratory gas; (2) to nitrogen narcosis and attendant mental confusion in flooding the escape trunk, particularly at pressures greater than 200 ft; and (3) to the physical shock induced on contact with cold sea water.

Studies of augmented training and improved techniques of escape from disabled submarines have been undertaken in our 100-ft-deep escape training tank. These include (1) studies in feasibility of free escape, wherein a man without benefit of a breathing device maintains positive buoyancy and floats to the surface, exhaling continuously to compensate for decreasing ambient water pressure; (2) a variation of free escape, wearing a flotation vest of about 25 lb buoyancy, thus greatly increasing speed of ascent and requiring that expiration be maximal throughout the ascent; and (3) (an absolute necessity for escape in very cold water), a waterproof coverall garment. It is recognized that at water temperatures of 32 to 34 F shock ensues and death may occur within 10 min. This protective garment will be a lightweight, snag-resistant, hooded, coverall, economical in stowage and slow in deterioration, which, if free escape be found feasible for general training, may supplant the present submarine escape appliance. It is planned that helium-oxygen mixture be breathed during the flooding-down period preparatory to escape in order to obviate the nitrogen narcosis incident to breathing air under high pressure.

PERSONNEL SELECTION

The Submarine Force is a relatively small organization, comprising at the height of its strength during the past war, less than 2 per cent of the Navy's population. Submarining is a young man's game, appealing to the individual who demands and can accept responsibility superior to the degree connoted by his rank or rate. Submarining is tough, demanding for success the best that a man can give in long hours, hard work, reliability, initiative, perseverance, and versatility. Yet the service must be generous in return, judging from the resistance commonly seen offered by men and officers who for physical or other reasons must be transferred to other duty.

A submarine crew is a team; team play and the utmost in co-operation and mutual assistance are the keynotes of the submarine esprit de corps. All submarine personnel are volunteers. There is close association between officers and men, with mutual respect for the others' welfare and capabilities—the "one-for-all and all-for-one" spirit—provided of course that the given man "belongs in submarines."

A submarine is an intricate complicated machine, built with the precision of the watchmaker's art. It is an effective but highly vulnerable craft. A submarine and a submarine's crew make but one serious mistake in their lifetime. For this reason it is mandatory that submarine personnel be selected not only for their physical condition, but also for their ability in special senses, their emotional maturity and stability, and freedom from psychopathic tendencies.

It is unnecessary to belabor the premise that not all men are acceptable for submarine duty. On the other hand, it does not follow that submariners are the ultimate in personnel. As a general statement, the average submariner is an individual who is average or above in mental capacity and education, who is strong, healthy, and who is well adjusted emotionally and temperamentally to himself and his fellows, and who "wants" submarine duty.

During the recent war, selective screening processes were developed, endeavoring to produce submarine crews of the highest possible efficiency and with minimal discard loss of trainees; an economy of time and men was imperative.

PERSONNEL-SCREENING PROGRAM

A selective screening program to the uninitiated carries a connotation of mystery; actually, it has been found that requirements are met by the following process:

1 Elimination of personnel below median intelligence by means of a standardized battery of intelligence tests requiring $2^1/_2$ hours for completion.

2 Maintenance of reasonably rigorous physical requirements, particularly as regards special senses and freedom from disease.

3 Acceptance of only those men highly motivated for the Submarine Service.

4 Elimination of personnel considered to be unstable emotionally, immature, and temperamentally ill-adapted to close living conditions aboard submarines on long patrol—the neurotics and others having psychopathic tendencies. The physical status and mental qualities of individuals are amenable to measurement; the temperament, emotionality, and psychiatric evaluation of the individual obviously are more difficult of determination and more subject to error. A judgment of these factors is made on the basis of written personality inventory tests, used only as a rough screening measure, by means of a personal interview conducted by a medical officer trained in submarines and employing a psychiatric approach; and by emotional reaction of the candidate during submarine-escape training.

Perhaps there may be interest in some of our thought, findings, and attitudes in efforts to pick the right man for the job and keep the wrong ones out.

In general, we find that men do better and are more desirable who originate from a solid secure home background, who made satisfactory progress in school (preferably through high school) both as regards scholastic ability and absence of noteworthy disciplinary problems, and who are interested in and have endeavored to participate in active team sports. Mechanical aptitude is important. Those who have worked with tools, either as a profession or as a hobby, "the tinkerers," find that their interest and aptitude stand themselves and the service in good stead.

Certain signs on examination and interview must be considered as placing the candidate in a very doubtful category; a bad civilian or military record, a ne'er-do-well, repeated shifting of jobs for no real reason or without real benefit, repeated discharges from employment, as many as two divorces, or repeated familial difficulty, repeatedly being placed "on report" in military life, serious infraction of civil law or military discipline, somatic manifestations such as nail-biting, constipation, frequent upset stomach, diarrhea, or headache, walking or talking during sleep, fainting, unduly rapid heart rate, excessive frequency of common colds, or history of being a bookworm as a child rather than indulging in normal play. A state of undue tension during examination or interview, indicated by aberrations in blood pressure, wet palms, tremors, exaggerated tendon reflexes, we consider to indicate anxiety with emotional instability.

In the personal interview we try to evaluate the individual as to motivation, maturity, stability, dependability, and attempt to determine the possible presence of personal characteristics which might militate against satisfactory adjustment in submarines, where intimacy of living conditions and team

play are unparalleled. These elements usually are not too difficult of judgment. It is helpful to think of the problem as one of selecting companions for a long hunting or fishing trip into frontier country where every man must be willing and capable of doing more than his share and of maintaining an attitude unobjectionable to his fellows when the going is worst. He must "fit and belong." The crux of the matter is: "Do I want to go to sea with him?"

Proficiency in interviewing comes only with experience and interest. Good rapport must be established early. Each subject is one to be treated separately, as occasion demands and the personality of the subject dictates. For these reasons, no stipulated form is followed, particularly as regards the opening moments, during which the interviewer endeavors to establish a free informal relationship.

As the candidate enters, an excellent approach for "breaking the ice" has been found to be a cursory medical examination to include and observe reflexes, tremors, sweaty palms, pulse rate, ataxia, ocular imbalance, muscular weakness, nail-biting, and speech defects.

Rarely, in any situation does one learn by talking. This is particularly true in an interview. We encourage the subject to talk, leading him by deft questioning into the desired channels. An excellent opening is to inquire as to the candidate's reason for desiring submarine duty.

Inquiry is made into family environment and health. His school background, and school-age interests and tendencies are touched upon, together with any noteworthy disciplinary problems, and infraction of civil law.

The subject's nonindulgence or degree and occasion of indulgence in intoxicants may reveal an interesting insight into his personality.

His social and sexual habits and tendencies are worthy of interest. His adaptability and adjustment in society are highly important.

We can best predict future action and achievement of the individual by learning of his past. So an impression is sought as regards judgment, decisiveness, maturity, drive, and insight. Much may often be learned by inquiring into his ambitions, past present, and future, and the degree of success attained in pursuing them.

Depending upon rapport which has been established, a very valuable line of discussion may follow questions as to criticism others make or might make of the candidate, and self-criticism, or faults which he might find in himself. Likewise, an itemization of assets which others state or which he might feel that he possesses are frequently revealing.

It is considered imperative to take cognizance of the candidate's general knowledge of and facility with commonplace information and universally used mechanical appliances as an index of his alertness and common sense. His answers to queries on current events and personages — local, national, and international, are indicative. Also, almost everyone, for example, drives an automobile. It is hardly conceivable that individuals having the desired alertness, acumen, and mechanical curiosity would not have explored the basic mechanics and "whys" of this common contrivance. Yet it is not unusual to find men who have driven automobiles for 10 years who cannot explain the basic fundamentals of the internal-combustion engine, the differential drive, the transmission, or carburetor. This line of questioning is most profitable and in interview is oriented to the background of the individual candidate.

It is well realized that the results obtained from quizzing candidates in interview may be far from the subject's true mental ability. Not infrequently a college graduate may be completely confused in such a procedure. This "buck fever," an indubitable indication of emotional instability under stress, is of great interest to the examiner in evaluating the man for a duty where opening the wrong valve in an emergency may be disastrous.

EFFECTIVENESS OF SUBMARINE SERVICE AND SELECTION OF PERSONNEL

The effectiveness of the submarine service is indicated by the fact that less than 2 per cent of the navy accounted for 77 per cent of Japanese shipping losses. The effectiveness of the selection program is more difficult of statistical proof due to many obvious factors, the principal one being that there can never be any data on the submarine performance of men not accepted for submarines, and the difficulty of securing adequate "unhaloed" reports of performance of all submarine-school graduates from submarine commanding officers. However, several hundred reports were received by arrangements with submarine officers on a form prepared at the laboratory, in which judgment was requested as to the desirability of the man. The crux of the report, "Adequacy of over-all performance," classified 8 per cent of the men as "inferior, would like to replace"; 76 per cent as "satisfactory, desire to retain"; and 16 per cent as "extremely valuable, especially desire to retain." These data support a favorable comment particularly when considered in the light of a fleet attrition in excess of 60 per cent, which occurred in a group of 250 unselected men sent to the submarine service in the very early days of the war.

Research Rocket

MAKING its first flight, a Glenn L. Martin Company designed and built Viking research rocket was launched at the White Sands, N. Mex., proving ground May 3, reaching an altitude of $51^1/_2$ miles, the National Military Establishment announced recently.

The control system functioned perfectly on the five-minute flight, and the rocket landed on course 10 miles northwest of the launching site. Officials of the Navy, who supplied details, pointed out that altitude was not the primary purpose of the first flight, the chief object being to test the functioning of the power plant and control system.

At "burn-out," or when the fuel was exhausted, the Viking was traveling at a speed of 2250 mph, three and one-half times the speed of sound.

Comparable in size to the German V-2, the Viking is a single-stage upper-atmosphere research rocket which, on subsequent flights, is expected to reach altitudes of 200 miles or more for research in cosmic rays, atmospheric composition, radio propagation, photography, and spectroscopy.

No guidance other than stabilization is necessary for upper-atmosphere research flights. Navy spokesmen pointed out that the Viking is designed as a technical research vehicle and not as a service weapon. However, they added that adequate movable controls are available for guidance and that guidance systems now under development could be modified for incorporation in the Viking to provide a controlled missile, if desired. Also, the weight-carrying capacity and stability of the Viking make it adaptable for the first or intermediate stage of a multistage rocket.

The power plant, the most efficient rocket motor yet developed in this country, was developed and manufactured by Reaction Motors, Inc., of Dover, N. J. The entire Viking development project is under the direction of the Naval Research Laboratory in Washington, D. C.

ARABIAN OIL[1]

By M. A. ADELMAN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

"THE oil center of the world is shifting from the Western to the Eastern Hemisphere." The picture magazines have by now made most of us vaguely aware that suburban bungalows, supermarkets, and business offices—all air-conditioned—exist in a land that would have been regarded as hopelessly backward by most citizens of the Roman Empire. The present development of Middle East oil is a massive engineering conquest of deserts, distance, and heat; it involves equally great problems of social and economic adjustment, reaching thousands of miles away from the Persian Gulf. Hence the story of Arabian oil is of great interest to engineers and economists alike, and it is therefore appropriate that this new book[2] should be the joint product of an economist and an engineer with economic training.

The basic facts are simple. The world consumes something more than 12 million barrels of petroleum products every day, and is constantly using more. From time to time in the past, the rising trend has been charted, and predictions have been made that it *must* flatten out soon. So far, the prophets have always been wrong, and for the years ahead the outlook is for ever-greater use. As the economy of Europe revives, it will reinforce the insatiable demand of the United States. To the extent that our "bold new program" of aid to undeveloped areas becomes a fact, we will be teaching them to use petroleum products. Nor is there, unfortunately, any need of a reminder that modern war is propelled by oil.

Of the seventy or so billion barrels of proved oil reserves in the world, the United States has about thirty per cent and the Middle East about forty-five per cent. Yet in 1947 the former was extracting between five and six times as much crude from its smaller supply. The cost of finding oil in the United States quintupled in less than ten years, from 1935–1937 to 1945. Since we are taking out some nine per cent of our oil reserves every year, the present ratio of reserves to production, lowest since 1923, "is considerably lower than the 'normal' fifteen years' supply which the industry should have for efficient operation and conservation."

The cost of production abroad is much less: Fully seventy-three per cent lower in the Caribbean and an unbelievable eighty-four per cent lower in the Middle East. Even allowing for transportation, taxes, etc., oil from Arabia or Venezuela can be delivered to the Gulf Coast at a lower price than oil from Texas. Therefore economy and military security both point toward conservation of domestic supplies and greater reliance on the Middle East; an end to American oil export and as much importing of oil as seems advisable. That this is politically impossible at present the authors probably know but do not mention. But so far as the Eastern Hemisphere is concerned, its oil supplies must come from the Persian Gulf.

For the time being those supplies are barely keeping up with European demand. The bottleneck is not in crude oil, production of which could easily be stepped up, but in refining and transportation, which are limited chiefly by the steel shortage. When the book was written, it seemed impossible that the program of the Marshall Plan countries for greatly expanded petroleum consumption should be fulfilled. The easing of industrial activity since mid-1948 has led to actual production cutbacks in both the United States and Arabia. But this is merely a pause between two upward leaps.

Most of the development of Arabian oil is being carried on by corporations whose names are familiar to every motorist: Standard of New Jersey, Standard of California, the Texas Company, Gulf Oil, and Socony Vacuum. A few others have entered since the book was written, or at least they have thrust a foot into the doorway, but the share of these newcomers will be small. The giants already mentioned, along with Anglo-Iranian, Dutch-Shell, and a French company, *are* Middle East oil.

The overseas operations of these companies differ substantially from those at home. One figure speaks for itself: All the vast reserves of the whole Persian Gulf have been proved by less than 150 wildcat wells; in the United States more than 20 times that number are drilled every year. The average United States well yields eleven barrels of oil daily; the Venezuelan, 220 barrels, and the Middle Eastern, 4000. Concessions covering thousands of square miles are granted to a single company or syndicate, and each oil field is operated as a unit—derricks are few and far between. Huge sums must be invested before a barrel of oil is produced; by the end of 1946, the Arabian American Oil Company (Standard of New Jersey, Standard of California, Gulf, and Socony-Vacuum) had invested $120 million. In that year they earned $18 million, most of it plowed back into the business. Much more investment will be needed: of the six pipe lines planned to avoid the long trip by tanker around the Arabian peninsula, the single one from Abqaiq in Saudi Arabia to Sidon and Haifa on the Mediterranean coast will cost $22 5million. Over the five-year period 1948 to 1953, "Aramco" plans to spend not quite $2 billion.

The huge size of these investments, the heavy risks assumed when the explorations were started (it is only fair to add that the profits are expected to be quite commensurate with the risks), and the need to co-ordinate production with refining and transportation, keep the competing companies down to around a half dozen. The companies are governments in miniature, and negotiate as such with the kings, sheiks, and shahs of the Middle East. They have shared markets and consulted on development areas; some are allied through joint ownership of producing or marketing subsidiaries. The authors of "Arabian Oil" can see very little competition in the Middle East, although they note that "the number of producing countries is increasing, and their pressure for royalties may prevent any monopolistic restriction in the supply of oil. Second, the number of important international oil companies has grown from three to seven and may increase further . . . The danger of effective cartel restrictions on output decreases as the number of participants grows."

Since the book was written, however, the situation they describe has led to difficulties with the Economic Cooperation Administration. During 1948, some Middle East oil was sold in the United States; deduction of costs of shipping left a net price at the Arabian shipping point which was lower than the

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Arabian Oil," by Raymond F. Mikesell and Hollis B. Chenery. Chapel Hill, University of North Carolina Press, 1949.

price charged to ECA for shipments into Europe. But to cut the European price would put it below the level at which Gulf Coast crude was selling in Europe; a two-price system would need to be enforced by rationing. In other words, so long as most oil actually arrives from our Gulf Coast, its laid-down price in Europe determines the price for oil from the Middle East. But the authors note that as shipments from the United States become of relatively small importance, the attempt to collect extra freight ("phantom freight") on shipments from the Middle East will be strongly resented. It is this interplay of economic and political forces which makes the authors advocate an international petroleum commission as a semi-independent constituent organization of the United Nations, whose decisions would be enforced by the respective member organizations.

A few criticisms must be made of this useful little (197-page) book. It barely hints at the remarkable "As Is" agreement among the oil companies; and the "Red Line" agreement of 1928 is given little more attention. In consequence, the general reader may not be convinced by the authors' thesis that competition is in need of safeguards.

There are some minor mistakes. First, it is not true that Diesels are "supreme in ocean transport" (p. 158); in the year 1939 some 80 per cent of world shipping was powered by steam turbines, of which about half burned coal. About half of postwar construction, however, has been Diesel. Second, it is technically correct but misleading to say of the United States that "the new discoveries of oil in the past fivey ears (1942 to 1947) have been less than the amount produced" (p. 10), for the total additions to proved reserves include more than new discoveries. In fact, total proved reserves were 19.6 billion barrels at the beginning of 1942 and 20.9 billion at the beginning of 1947. Third, there is evidence of haste in writing: as the authors note, the statistics in the text do not always check with the later ones in Appendix II; and the table on foreign and domestic investments of American oil companies refers to 1937, when it could have been brought down to 1947 from an easily available source.

Furthermore, much of Appendix I on petroleum economics (an area where the engineer's interest overlaps the economist's) is of dubious value. The general discussions of monopoly and competition are too sketchy for the professional economist, and so much gobbledygook to others. Both groups can recognize that reference to "the lack of integration in the automobile industry" is rather less than a half truth. Finally, the discussion of basing-point systems fails to distinguish them from simple freight equalization in highly competitive markets. Since the former are presumably illegal today and the latter are not, this is a more than academic distinction.

These are all minor blemishes, which can easily be removed in the next edition, and detract little from an interesting and timely book.

Industrial Research

(*Continued from page 582*)

hensive manner, the engineer can then plan on how best to make its presentation. The presentation will depend in a considerable measure upon the characteristics of the man or men with whom he has to deal. This needs careful planning so that the particular interest of these executives is considered. Stress can be laid upon the financial advantages or social gains that will accrue from accomplishment. Or, it may lead to a broadening of the field of activity of the industry with resultant advantages.

Sometimes it is well to interest certain of the executives separately and to gain their support before taking the idea to the top men. One then has friendly support down the line which helps with the leaders. As stated before, different approaches may be made in different situations, for personality and psychology are factors to be considered.

CONCLUSIONS

The preceding discussion demonstrates that research is needed by small industries to maintain their competitive positions or extend their operations. Fundamentally, the idea for the new development must originate in the organization of the small industry. The person originating the idea must develop it sufficiently to be sure of its economic value and must sell the need of further research to the industry's executives. There are many research organizations available to small industries that will undertake the necessary research and development at a reasonable cost. Thus American small industries can avail themselves of the full advantages of industrial research.

Problems and Significance of Our Alliance With Socialist Europe

(*Continued from page 564*)

here and there demonstrable cases of need and distress do exist. Let's keep our eyes on the ball.

PUT AN END TO HANDOUT LEGISLATION

Disregarding handout legislation born of purely political considerations, much of the havoc which is wrought in our national picture is the result of well-meant but ill-conceived legislation by people who just don't look beyond the ends of their noses, who seem constitutionally unable or temperamentally unwilling to count the cost before they speak and act. Carried away by the creative thrill of building a brave new world, they rush into projects of staggering proportions, bent on "doing good for mankind" with never a glance backward to measure the enervating impact upon the economy which must support their grandiose abstractions. I wrote a little jingle about their kind recently entitled, "Thoughts on the New Thought, or the Theoretical Convolutions of a Complex Variable." It goes like this:

It very often seems to me that every brave New Thoughter
Is more than likely prone to think the things he thinks he oughter
Forgetting that the boons he seeks, of which he feels a dearth,
May cost us all in sweat and tears far more than they are worth.

These love abstract complexities, possessing convolutions
Which render very difficult arrival at solutions,
Requiring cogitation deep and colloquies semantic,
Extraordinary verbiage, obscure but so romantic.

But when their philosophical debate can find no more
To discourse on, I still reflect that two and two make four.
As old J. Pierpont Morgan once averred, a guy cannot
(if wondering what the cost will be) afford to run a yacht.

In all my thinking let me see
The virtues of simplicity,
For complication tends to bind
The sinews of my feeble mind.

To get things down to brass-tack terms
Helps out this poor weak brain which squirms
When one who "digs" is said to "grovel"
And folks won't call a spade a shovel.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Technical Institutes

THE fifth "Annual Survey of Technical Institutes" has been prepared by Leo F. Smith, chairman, and Maryfrances Dudley, Educational Research Office, Rochester Institute of Technology, and appears in the May, 1949, issue of *Technical Education News*.

Institutes have been classified according to type or control as follows: State maritime academies and Federal schools; state and municipal technical institutes; extension divisions of colleges and universities; proprietary technical institutes; and YMCA schools. In the present survey, enrollment figures are included for 81 schools as compared with 82 a year ago.

The report reveals that in the 81 schools reporting, 33,326 regular day students were enrolled as of Jan. 2, 1949, which represents an increase of 7.8 per cent, as compared with 30,927 such students enrolled in 82 schools in 1947–1948. In addition, 19,531 evening and special students were enrolled this year, an increase of 16.8 per cent over the 16,714 reported last year. The grand total of 52,857 reported this year is an increase of 10.9 per cent, as compared with 47,641 enrolled in 1947–1948.

STATE MARITIME ACADEMIES AND FEDERAL SCHOOLS

The enrollment in state maritime academies and Federal schools shows 474 this year compared with 821 reported a year ago.

In addition, Comdr. Arthur J. Spring, director of the U. S. Maritime Service Institute, has provided the following information regarding the present program offered by the Service:

1 USMSTS, Sheepshead Bay, Brooklyn, N. Y.: refresher training in deck, engine, and steward departments and in radio subjects—about 350 enrolled monthly.

2 USMSTS, Alameda, Calif.: same as above, plus courses for original deck and engine licenses—approximate monthly enrollment 150 to 200.

3 USMSTS, St. Petersburg, Fla.: apprentice seaman training—approximate annual enrollment 800.

4 USMS Institute, Sheepshead Bay, Brooklyn, N. Y.: correspondence courses in deck, engine, radio, and academic subjects—approximate annual enrollment 4300.

5 Radar and Loran Operational Schools, New York, N. Y., New Orleans, La., and Alameda, Calif.: operational training in the use of radar-loran equipment to licensed deck officers.

STATE AND MUNICIPAL INSTITUTES

A regular day enrollment of 8707 in the 17 state and municipal institutes was reported, as compared with 5897 reported by the same number of institutes last year. This increase is due largely to increased enrollment in the New York State Institutes of Applied Arts and Sciences.

California State Polytechnic College has a unique system that provides for self-owned and managerial projects operated by students. In the agricultural division popular projects are fattening livestock; raising sheep, swine, and beef and dairy cattle; and other types of individual projects. In the industrial division projects are generally on a group basis. In aeronautics, for example, aircraft and engines damaged beyond feasible commercial repair are overhauled for their owners, or are purchased outright and rebuilt by students.

The New York State Agricultural and Technical Institute at Canton has acquired farm buildings and facilities along with 360 acres of land, which will be utilized as an integral part of the program in agricultural technology. During the past year, two co-operative work programs were initiated—one in agriculture, the other in heating, plumbing, air conditioning, and refrigeration.

During 1948 the New York State Institute of Applied Arts and Sciences in Brooklyn acquired a new building containing 40,000 sq ft of floor space that will be used for retail, art, and hotel courses.

PRIVATELY ENDOWED INSTITUTES

A regular day enrollment of 4399 was reported in ten privately endowed institutes, compared with 4851 a year ago by the same ten schools.

During the past year, the Pittsburgh Institute of Aeronautics built a new engine-test building at the Allegheny County Airport Base and received a AYP-59 jet-propulsion airplane. Also, a new 15-month course in drafting and design was initiated.

Five of the eight departments at the Rochester Institute of Technology operate on a co-operative-work-program basis. During the present school year, 984 students are receiving co-

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

operative-work experience. This program, in operation since 1912, is currently functioning in the Electrical, Food Administration, Industrial Chemistry, Mechanical, and Retailing Departments.

Wentworth Institute reports a 50 × 80-ft addition to the aircraft laboratory.

EXTENSION DIVISIONS OF COLLEGES AND UNIVERSITIES

A regular day enrollment of 2755 was reported in the six extension divisions of colleges and universities reporting, as compared with 1853 reported by four institutions last year.

This year for the first time, the Technical Institute Division of Georgia Institute of Technology is included. This institute, located at Chamblee, Ga., is housed in a building leased from the Navy. L. V. Johnson, director, reports that this is the only two-year terminal course in Georgia preparing students to go directly into industry.

Enrollments are also reported for New York University's Division of General Education. A wide range of courses, offered in the evening, are aimed at men who are currently working in industry.

The Technical Institute of Fenn College reports a new program in industrial methods, and a new course in quality control.

The Industrial Management Institutes of the University of Wisconsin are short intensive programs for people already employed in industry. It is reported that they have a new building that houses administrative offices and two conference rooms.

At Utah State College a new $225,000 technology building, provided with up-to-date equipment and instructional facilities, has just been completed.

PROPRIETARY TECHNICAL INSTITUTES

The regular day enrollment in the 24 proprietary technical institutes reporting is 16,575, compared with 16,783 reported by 21 institutes a year ago.

The Academy of Aeronautics at LaGuardia Field, Flushing, N. Y., reports that courses in jet propulsion added during the past year drew considerable publicity in the daily papers.

The largest full-time enrollment in any of the 81 institutions reporting this year was 3480, reported by the American Television Institute.

Cal-Aero Technical Institute also reports a new course in jet-propulsion mechanics.

Capital Radio Engineering Institute reports approximately 10,000 active students enrolled in its correspondence course in practical radio engineering.

Philadelphia Wireless Technical Institute reports that new broadcasting studios were to be opened in February, 1949. Also, a new two-story refrigeration laboratory is being erected.

The RCA Institutes moved to new enlarged and improved quarters and are now located at 350 West Fourth Street, New York, N. Y.

YMCA SCHOOLS

Enrollment figures from the three YMCA schools reporting total 416 regular day students, compared with 722 reported by two schools last year.

During the past year the name of the Dayton YMCA Junior College was changed to Sinclair College. A house adjoining the YMCA building was purchased, providing seven additional classrooms.

The YMCA-Technical Schools in Seattle added during the last year about 12,500 sq ft for an engineering index and for courses in illustrative engineering.

CANADIAN SCHOOLS

The following Canadian schools were included in this year's survey:

The Provincial School of Papermaking, founded in 1923, moved into a spacious new building in 1944. Students are accepted at the end of their tenth year for the three-year curriculum. The title of Certified Technician in Papermaking is conferred upon graduates.

Lakehead Technical Institute opened in January, 1948, and offers a two-year course in mining to graduates of Ontario secondary schools.

The Montreal Technical School offers a four-year technical course to pupils who have passed their second year of high school. It is, therefore, partly a technical high school and partly a technical institute. Students specialize in machine shop, foundry, electronics, patternmaking, carpentry, or electricity.

The Provincial Institute of Technology and Art in Calgary, organized as a technical institute in 1916, offers a wide variety of courses.

The Provincial Institute of Textiles opened for full-time day classes in September, 1947. It is located at Hamilton, the chief center of the primary textile industry of Canada.

CONCLUSIONS

The following generalizations are drawn from the survey:

1 Enrollment in technical institutes continues at a high level, somewhat above that of a year ago, with 52,857 students enrolled in 81 institutes that reported.

2 The largest increase in enrollment is reported by the state technical institutes, specifically those in New York State.

3 Pressure for academic respectability continues. This is evidenced by the fact that the New York State Maritime Academy and the New Bedford Textile Institute have become degree-granting schools. Likewise, the Dayton YMCA Junior College has changed its name to Sinclair College.

4 The Rochester Institute of Technology is still the largest technical institute, with a total day and evening enrollment of 4729 students on Jan. 2, 1949 (5261 as of Mar. 1, 1949).

5 In the proprietary institutes there has been a trend toward courses in jet propulsion and television.

Regardless of the name that might be given to courses that prepare young people for industrial and technical occupations, it appears that the technical institutes can, if properly conceived and administered, make a distinct contribution to American education.

Tax and Expenditure

THE Committee for Economic Development, a nonprofit, nonpolitical organization of American business leaders, has issued another statement in its series of national policy studies. See MECHANICAL ENGINEERING, January, 1948, p. 17. The purpose of the CED is to help determine through objective research those economic policies that will encourage the attainment and maintenance of high production and employment within the framework of a free society.

This statement is on "Tax and Expenditure Policy for 1949," and deals with tax and budgetary policy for the fiscal year 1950. It examines the President's budget proposals and the issues they raise, suggests means of making control of government expenditures more effective, and points out the implications of spending on the scale proposed.

The President's cash-consolidated budget for the fiscal year

1950, plus an unofficial estimate for foreign military aid, calls for $46.3 billion. This is $9.8 billion more than actual expenditures in 1948. The chief forces at work to raise Federal expenditures are as follows: (1) A great increase of programs for national defense and foreign aid; (2) a large increase of domestic programs, mainly for social welfare and resource development; (3) the proposed payment of $2 billion of accumulated dividends on veterans' life insurance; (4) an increase of about $750 million for farm-price-support operations resulting from lower farm prices; and (5) higher costs owing to higher prices and government wage rates.

Each new expenditure should be put squarely to this test the report states: Is it worth the additional taxes needed to finance it? Does the gain from added expenditure exceed the loss from higher taxes?

More informed public participation in the control of government expenditures, according to the CED, depends on the four following main improvements in budgetary procedure: (1) To make summary budget tables more meaningful, the cash-consolidated budget should be substituted for the administrative budget in presenting budgetary facts to the public; (2) policy issues should be clarified by improved classifications through the use of a "performance budget" in which each activity and project will stand by itself; (3) a shorter budget statement should be issued; and (4) choices on new and proposed programs and on existing commitments for the future should be more sharply defined in order to help the public in its decisions.

The CED report states further that apart from doing the existing jobs of government at lower cost, the search for savings will be most fruitful in those areas where we are currently being asked to undertake new or expanded commitments, rather than in those in which we are bound legally or morally, by past actions.

Although the CED says we will have to accept large Federal budgets until true peace is achieved, they believe that a tax increase is unnecessary because, barring major unforeseen international developments, expenditures for fiscal 1950 can be reduced. Government functions which are part of our national policy must take priority over the private expenditures they replace, but economy in government and reduction in projected government expenditure are compatible with this policy.

Titanium

TITANIUM, the important, newly refined metal, will compete with aluminum alloys in marine and aircraft application, a Yale University metallurgy expert predicted recently.

Champion H. Mathewson, professor of metallurgy and metallography at Yale, declared that many metallurgical organizations are striving to discover practical ways of extracting titanium from its ore, the greatest difficulty yet encountered in connection with the metal. They confidently expect to produce flexible titanium at greatly decreased costs.

The metal is steel-like in appearance and in strength, he said. It does not corrode in air. Furthermore, it is light, somewhat less than halfway in density between aluminum and iron. This gives it the highest strength-to-weight ratio of any competing metal and with any luck at all in the alloy effort this superiority will be greatly enhanced.

However, the metallurgist cannot separate the metal away from the oxygen in the mineral which constitutes the primary ore except by very specialized operations at great expense.

If he uses simpler operations, other impurities that spoil the metal are unavoidably introduced. This metal, which is so resistant to contamination at atmospheric temperatures, is extremely reactive at high temperatures, and to make matters worse, has a very high melting point which interferes with easy casting.

New mining and refining processes, when developed, will not bring titanium into competition with the vast quantities of steel used in buildings, bridges, or ships, Mr. Mathewson said. On the other hand, stainless steel, which might be its natural competitor, contains the expensive elements of nickel and chromium and presents its own difficulties of fabrication.

We must think of these specialized or alloy-steel products as competitive from the point of view of cost with copper-base alloys such as the high-strength bronzes, and not with the simplest forms of steel, he asserted.

The Yale metallurgist assured that there is no danger of the world supplies of copper, lead, and zinc running out in the near future, if we are not confronted with war. Titanium and manganese, in addition to aluminum and magnesium, will safeguard the future by offering a great abundance of very useful base metals, to say nothing of their value as alloying additions to other base metals.

Professor Mathewson pointed out that engineers are becoming enthusiastic about the possibilities of a rich selection of material to implement their progress in a new age of astounding mechanical efficiency. He said that with titanium and manganese, plus some 20 less familiar metals, the list of alloy pairs, largely unexploited but potentially useful, comes to about 560.

Possibilities run extravagantly far beyond this, he explained, because we commonly use more than two elements in an alloy and the number of possible combinations of such complexity runs into fantastic figures.

This explains the growing interest in alloys research in universities, government laboratories, industrial plants, and private research laboratories. The future looks bright in this area of research and experimentation.

Gas-Turbine Locomotive

THE first gas-turbine electric locomotive to be built and operated in the United States, an Alco-G-E 4500-hp unit, has completed preliminary road tests and will see further service soon on the Union Pacific Railroad.

The preliminary tests were made in the East over a period of several weeks during which the developmental locomotive performed successfully on freight-haulage runs. Additional road trials will get under way when the gas-turbine-powered unit is operated in freight service by the Union Pacific.

These announcements were made jointly by the General Electric Company and the American Locomotive Company at the G-E, Erie, Pa., plant during the first public track demonstrations of the new locomotive, June 16, 1949. The locomotive first took to the rails in November, 1948.

A paper discussing the design features of the 4800-shp gas-turbine power plant was presented by Alan Howard, Mem. ASME, General Electric Company, Schenectady, N. Y., at the 1947 ASME Semi-Annual Meeting, and appeared in the April, 1948, issue of MECHANICAL ENGINEERING, pp. 301 to 306.

In general, the design is similar to the TG-180 type and features a straight-through in-line arrangement of compressor, combustion chambers, and turbine. Air is drawn through a compressor into several combustion chambers. Fuel is injected and the mixture burns, raising the temperature of the compressed air. Resulting gases expand and move at great velocity against the turbine blades, turning the shaft. The shaft drives both the power-plant compressor and the generator. Power from the generator is supplied to eight traction motors, each of which drives one of the eight axles. The plant is

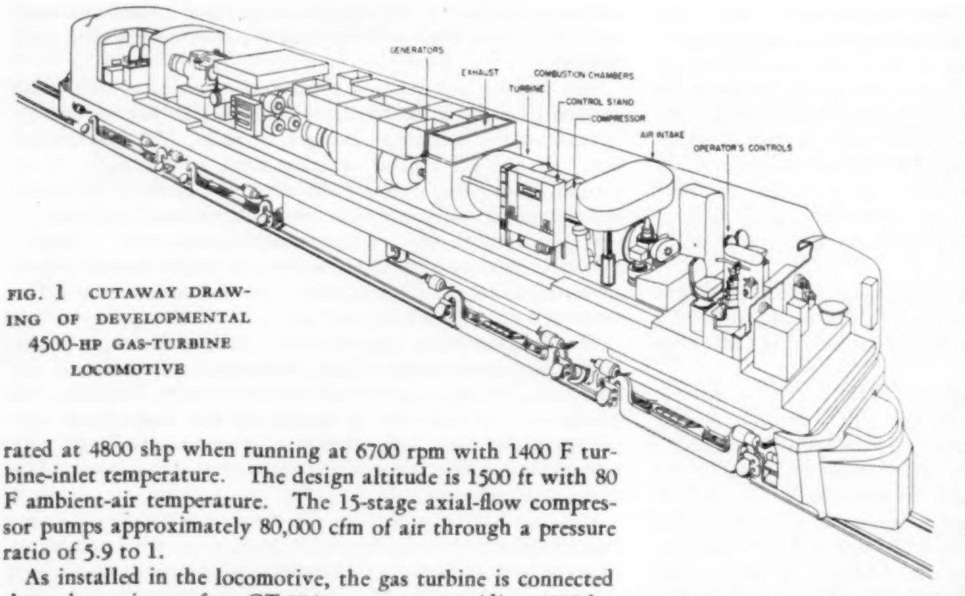

FIG. 1 CUTAWAY DRAWING OF DEVELOPMENTAL 4500-HP GAS-TURBINE LOCOMOTIVE

rated at 4800 shp when running at 6700 rpm with 1400 F turbine-inlet temperature. The design altitude is 1500 ft with 80 F ambient-air temperature. The 15-stage axial-flow compressor pumps approximately 80,000 cfm of air through a pressure ratio of 5.9 to 1.

As installed in the locomotive, the gas turbine is connected through gearing to four GT-576 generators providing 4500 hp for traction. The power unit is equipped with a G-E power-plant regulator of the variable-speed type.

From September, 1947, to August, 1948, this plant was on test at the factory in Schenectady. A paper describing the testing of the gas-turbine unit, giving test results, and discussing operating characteristics, was given at the 1948 ASME Annual Meeting by Mr. Howard and Bruce O. Buckland, Mem. ASME, also of the General Electric Company.

According to this paper, approximately 700 hr of operating time was accumulated during the test period. After the first 100 hr, during which all operation was on Diesel fuel, about 80 per cent of the operating time was on grade 6 fuel oil, and the remaining 20 per cent on Diesel fuel oil. Alco-G-E is also co-operating with the Locomotive Development Committee of Bituminous Coal Research toward a successful means of burning coal in a gas-turbine locomotive.

The unit delivered its rated power with an estimated turbine-inlet temperature of about 1300 F compared to the design temperature of 1400 F. At the rated power condition, the thermal efficiency was slightly over 17 per cent, based on the lower heating value of the fuel. The anticipated thermal efficiency based on shaft output and the lower heating value of the fuel was between 17 and 18 per cent. When operated with an inlet temperature of 1400 F, the output of the unit was approximately 6000 hp or 120 per cent of rating, and the thermal efficiency, based on lower heating value, approximately 18.5 per cent.

During the operating period, approximately 350 starts were made, and more than 200,000 gal ofBunker C fuel was burned. The amount of air pumped was in the vicinity of 2.5 billion cu ft. Somewhat over half the running was made on load cycles simulating heavy-load railway service.

The performance curves, based on these test results are shown in Fig. 2 which shows the tested fuel consumption versus speed for each of a series of exhaust temperatures. Lines of constant net shaft power output are also shown. These curves are corrected to the standard ambient temperature of 80 F and to sea-level pressure, 14.7 psi. The 100 per cent points correspond to 6700 rpm, 5000 hp, at sea level, and a heat input of a little under 75,000,000 Btu per hr, based on the lower heating value of the fuel. The guarantee value of heat input is 75,600,000 Btu per hr. These curves show that the exhaust temperature at rating is 780 F. Based on this exhaust temperature, the corresponding turbine-inlet temperature is calculated to be 1280 F. The design inlet temperature of 1400 F corresponds to an exhaust temperature of 850 F. As will be seen from the 850-F curve, the power at this temperature would be somewhat over 120 per cent of design value or more than 6000 hp. The fuel consumption would correspond to an efficiency of about 18.5 per cent, LHV.

The curves also show that at high powers the fuel rate is nearly independent of the operating speed, while at low powers there is a best fuel rate which occurs at reduced speeds. In locomotive operation, the control would set the speed to follow approximately this best fuel rate. For example, the normal idling condition is approximately 70 per cent speed, which requires about $^1/_3$ of full-load fuel flow. If full speed is maintained at idling, the fuel required is shown to be 47 per cent of rated flow.

The compressor efficiency at the rated condition, based on temperature rise and on impact pressures, is approximately 84 per cent at the pressure ratio of 5.9 to 1. The best efficiency occurs at a somewhat reduced speed and is slightly higher. The turbine efficiency at rated conditions, based on inlet impact pressure and on atmospheric-exhaust flange pressure, is approximately 84 per cent. The turbine is designed with a high axial

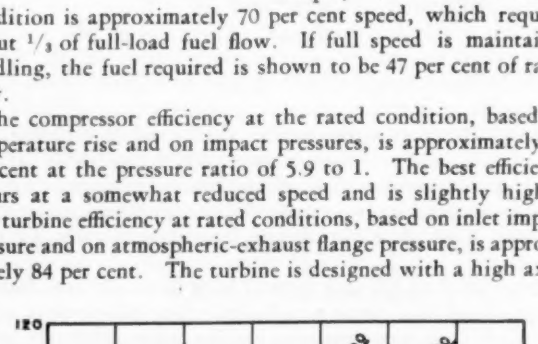

FIG. 2 TESTED THERMAL PERFORMANCE OF A 4800-HP GAS-TURBINE PLANT

[100 per cent values correspond to 75,000,000 Btu per hr (LHV), 6700 rpm and 5000 hp at sea level and 80 F ambient.]

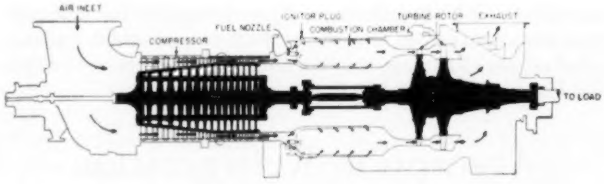

FIG. 3 AIR-FLOW DIAGRAM OF 4800-HP GAS-TURBINE LOCOMOTIVE

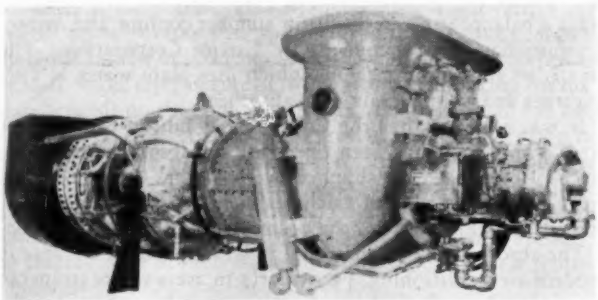

FIG. 4 EXTERIOR VIEW OF 4800-HP GAS TURBINE FOR LOCOMOTIVE DRIVE

leaving velocity, and the impact efficiency is about 88.5 per cent.

The unit is started by means of one of the main locomotive generators used as a motor, the power for which is supplied by a Diesel-engine-driven generator. The motor brings it to firing speed, about 55 rpm, in about 45 sec, when the ignition is turned on and Diesel fuel is admitted to the nozzles. Within a few seconds ignition takes place. During the next 155 sec the unit accelerates to idle speed, 4700 rpm, where it runs under control of the governor, ready for load but with Diesel fuel. The fuel is then transferred from Diesel oil to Grade 6 oil by the turn of a switch, after which the unit is ready for load with Bunker C. Power for the acceleration is taken both from the motor and the unit itself up to approximately 3500 rpm where the driving motor is disconnected by means of reverse-current relays. From this speed to idle speed the unit accelerates under its own power.

During the accelerating period and until idle speed is reached, the control mechanism regulates the fuel input to limit the maximum average exhaust temperature to about 875 F and to maintain it roughly at 750 F during most of the acceleration. Flame detectors incorporated in the control mechanism shut off the fuel and return the unit to firing speed if flame is not indicated within 30 sec after fuel is turned on.

The locomotive, as it was operated on actual road tests, is of single-cab construction with an operating station in each end and has B-B-B-B running gear. It develops 53-hp per ft of length, weighs 500,000 lb, and has a continuous tractive effort of 68,500 lb at 20.5 mph. It is 83 ft $7^1/_2$ in. long inside of knuckles, 14 ft $3^1/_2$ in. high over roofsheet, and 10 ft 7 in. wide over handrails. Geared for 79 mph, the locomotive carries enough fuel for 12 hr operation at 4500 hp.

Most of the area of the locomotive cab sides, except where there are sandboxes, is made up of air filters. This insures an ample supply of filtered air for combustion in the power plant and for equipment use.

Some of the details of the locomotive structure are as follows:

The cab underframe which supports both the apparatus and the cab structure, consists of two fuel tanks—one 31 ft long, and the other 21 ft long—separated by a dry-well section in the center. Beyond the shorter tank are two smaller tanks—one for Diesel fuel and the other for boiler water. This entire frame structure is about 33 in. high and 7 ft wide. It is essentially a box member interlaced with baffles which serve the double purpose of stiffening the section and preventing the fuel from sloshing. Stainless-steel heating coils are fabricated into the bottom portion of the tank to provide a means for warming the heavy residual fuel for easy handling. The tanks have a combined capacity of about 6600 gal.

The cab structure of this locomotive differs from the conventional truss type widely used on Diesel-electric locomotives. In this case, the underframe fuel-tank structure is stiff enough to carry the apparatus load and withstand the stresses encountered in operation. Consequently, the cab roof and sides are supported from this basic frame by an umbrella type of construction that carries the load, but does not contribute to the stiffness of the cab structure.

The nose sections and operating cabs at either end of the locomotive are symmetrical. The former house air-brake equipment, train control, and miscellaneous apparatus. The latter contain the usual operating stations, equipped with controllers, air-brake stands, instrument panels, and controls for cab heaters, defrosters, window wipers, sanders, whistle, and bell. Three seats for crew members are provided in each operating cab. These cabs are acoustically treated and in-

FIG. 5 PRELIMINARY ROAD TESTS OF THE 4500-HP GAS-TURBINE-ELECTRIC LOCOMOTIVE INCLUDED HAULING OF 85 LOADED FREIGHT CARS AT SPEEDS AS HIGH AS 65 MPH

sulated. They are separated from the equipment compartment by insulated bulkheads and doors. The central portion of the locomotive cab is the equipment compartment.

Double Turboprop Engine

AN article in *Engineering*, May 6, 1949, points out that at the present time there is a definite tendency in Great Britain toward using aircraft engines coupled together to form single power units. So far, this arrangement has been confined to the larger types of aircraft. There is a possibility, however, the article states, that the idea of coupled engines will be extended soon to smaller aircraft, as Messrs. Armstrong Siddeley Motors Limited, Coventry, announced recently the introduction of the Double Mamba, which consists basically of two Mamba II engines placed side by side. Although the two engines are joined together at the front, mainly by means of the air-intake casting and propeller-shaft reduction-gear casing, they are otherwise two separate power units with their own fuel, lubricating, and control systems. Each engine is provided with its own reduction gearing, which is arranged to drive one of two counterrotating coaxial propellers. The small over-all diameter of the Mamba makes it possible to obtain an exceptionally compact power unit with this arrangement, and the over-all dimensions are such that it should prove possible to fit the unit into a single-seat naval aircraft, thereby giving a considerably greater factor of safety. The manufacturers claim that the combination will give a high power-weight ratio for maximum-power operation with considerable economy in fuel consumption when cruising at low powers.

The combined compressor and turbine wheels rotate at a speed of 15,000 rpm, and this has to be reduced to a propeller-shaft speed of 1450 rpm, a reduction ratio of 0.097 to 1. This is obtained by a combination of epicyclic and ordinary spur gearing, the port engine driving the front propeller, and the starboard engine the rear propeller. Each engine is provided with its own epicyclic reduction-gear unit, which is driven through a helical-tooth sun wheel fitted to the forward extension shaft of the compressor. The sun wheel meshes with the larger wheels of three compound planet wheels, the smaller wheels of which mesh with a fixed gear ring, both the smaller planet wheels and the fixed gear ring having spur teeth. The front of each planet-wheel carrier is fitted with a spur gear which, on the port engine, drives a gear wheel fitted to the propeller shaft through an idler, and on the starboard engine, drives the propeller shaft through two idlers, the extra idler being provided on the starboard engine in order to give counter-rotation of the propellers. Apart from the extra idler, however, the two gear trains are identical. Each sun gear has 27 teeth and rotates at engine speed, namely, 15,000 rpm. The helical planet wheels have 38 teeth and the spur planet wheels 15 teeth, and both rotate at 9116 rpm, but owing to the action of the fixed gear rings, which have 63 teeth, the carriers, and therefore the integral spur gears, rotate at 2170 rpm.

On each engine the auxiliaries are fitted at the front and rear of the auxiliaries case, which is located just behind the air intake and engine-mounting casting. The drive is transmitted from the airscrew-shaft reduction gear through a single inclined bevel shaft which passes through one of the airfoils in the annular intake.

The complete unit has a width of 52.8 in. and a height of 42.35 in. The over-all length, measured from the rear face of the propeller-fitting cone to the rear face of the turbine housing, is 79.83 in., while the dry weight is 2000 lb. At sea level and maximum take-off rating at 15,000 rpm, the propeller-shaft horsepower is 2540 and the net jet thrust 770 lb, while for maximum continuous cruising at 14,000 rpm, and an aircraft speed of, say, 300 mph, the propeller-shaft horsepower is 2300, and the net jet thrust 225 lb.

Absorption Refrigeration

DEVELOPMENT of a refrigerating machine that employs steam for air-conditioning purposes—and thereby provides a balance in steam loads for summer cooling and winter heating—has been announced by Carrier Corporation. The unit is an absorption machine which uses plain water as a refrigerant and a simple salt as an absorbent.

It was reported that the Consolidated Edison Company of New York, Inc., has been operating an absorption machine since 1946, using steam supplied by New York Steam Corporation. A number of such machines were said to have been installed in various parts of the country with entire satisfaction.

The absorption machine is said to be a significant advance in modern air conditioning, particularly in areas where steam can be produced at relatively moderate costs, where there are district steam plants, where natural gas is available, or where a factory or department store or office building has a steam plant that is lying relatively idle in summer.

The unit will operate on either high or low-pressure steam, or even low-pressure waste steam. Aside from a small solution pump it has no moving parts, and therefore is practically noiseless and vibrationless.

It is lighter in weight and more compact than other heavy-duty refrigerating equipment, and is entirely suitable for installation on rooftops or intermediate floors as well as in basements. And with a low-cost source of energy and the use of water and a salt as a refrigerant-absorbent combination, operating costs are reported to be extremely attractive.

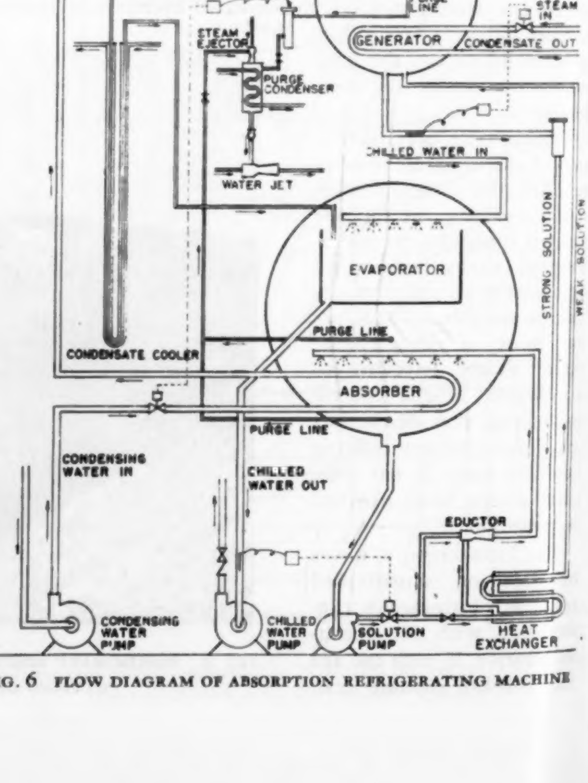

FIG. 6 FLOW DIAGRAM OF ABSORPTION REFRIGERATING MACHINE

The new machines are being produced in 115, 150, and 200-ton capacities, meaning that they are capable of creating a cooling effect equivalent to the melting of like amounts of ice each 24 hr. Single units will air condition areas of from 34,500 to 60,000 sq ft.

The machine consists of two shells, a heat exchanger, a solution pump, and auxiliaries. Its working cycle is as follows:

Water to be chilled is sprayed into the flash evaporator located in the upper portion of the absorber-cooler shell. Since this shell is maintained at a high vacuum, a portion of the chilled water evaporates and cools the remaining water. The chilled water drains from the cooler tank, and is pumped to the load. The temperature of the chilled water leaving the machine depends on the concentration and temperature of the salt solution sprayed over the coil located in the lower portion of the shell, which forms the absorber section. The salt solution absorbs the water vapor flashed in the evaporator. The heat of absorption of this vapor tends to raise the temperature of the solution, which is therefore cooled by water passing through the absorber coil in order to maintain the solution at a proper temperature.

The absorption of this water vapor reduces the salt concentration of the solution, thus also reducing its absorbing power. Therefore the weak solution is continuously drained from the absorber shell and delivered by the solution pump to the upper shell for reconcentration.

Reconcentration is performed in the lower portion, or generator section of the upper shell. Steam, admitted to the tubes, heats the solution and boils off the water vapor previously absorbed in the absorber section, thus restoring the original concentration.

It was reported that tests showed the present absorption machine operated at double the efficiency of the now largely obsolete ammonia machines, but also represented a lower initial cost because there was no need for rectifiers to purify the refrigerant.

For air-conditioning purposes, water chilled to 45 F is generally satisfactory. Where lower temperatures are required for industrial processes, these units will bring water down to 36 F. The present machine is said to use less than 20 lb of steam per hr per ton of refrigeration—no matter what the steam pressure. It will automatically adjust itself to partial loads down to 15 per cent of total capacity without loss of efficiency, and when higher tonnages are required it is readily adaptable to multiunit installations.

Boron-Treated Steel

In a previous investigation at the National Bureau of Standards, Washington, D. C., it was shown that the effectiveness of boron in enhancing the hardenability of certain steels depends upon the form of the boron at the time of quenching and not necessarily on the total amount of boron present.

In a recent research program the National Bureau of Standards has conducted an investigation of the hardenability of boron-treated alloys and steels with particular attention directed to the action of boron on the hardenability of these materials. This research has shown convincingly that the action of boron in increasing the hardenability is due entirely to a solid solution effect at heat-treating temperatures.

High-purity iron-carbon alloys containing 0.3, 0.5, and 0.7 per cent carbon and other high-purity alloys containing 0.4 per cent carbon and 0.7 per cent manganese, each type without and with about 0.002 per cent boron, were prepared for use in

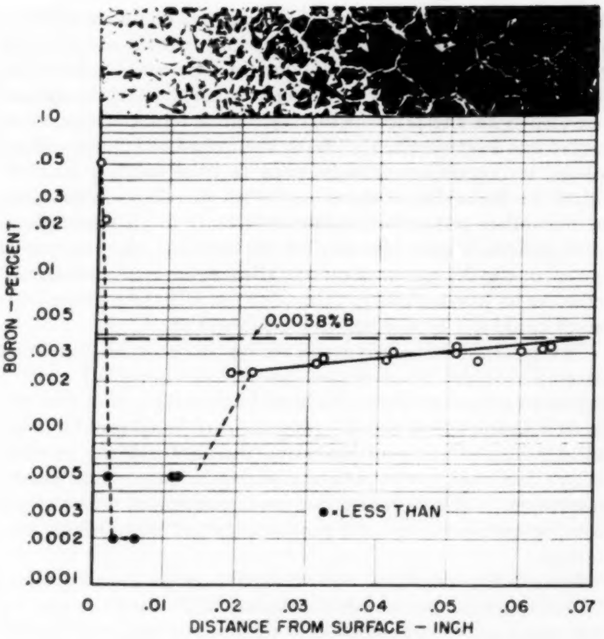

FIG. 7 DISTRIBUTION OF BORON IN A DECARBURIZED LAYER OF A COMMERCIAL BORON-TREATED STEEL, AS REVEALED BY A PHOTOMICROGRAPH SUPERIMPOSED UPON A PLOT OF DATA OBTAINED SPECTROGRAPHICALLY

[The specimen was decarburized by heating in a furnace (reducing atmosphere) at 1900 F for 8 hr followed by cooling in mica. The left edge of the photomicrograph corresponds to the original surface of the specimen, whose characteristic structure (not decarburized) is shown at the right.]

this investigation. In addition several commercial and open-hearth steels (0.4 per cent C, 1.6 per cent Mn) were included. Determinations of the hardenability of the alloys were made in terms of the "critical cooling rate" which is the slowest rate at which the alloy or steel can be cooled and be completely hardened; the standard end-quench test was used for evaluating the same properties of the iron-carbon-manganese alloys and commercial steels. Specimens prepared from the alloys in the conditions as cast, as forged and homogenized, and as heat-treated in various ways to precipitate a boron constituent were studied metallographically. Experiments were also made to determine whether boron was lost during the decarburization of commercial steels and for determining the rate of diffusion of boron in austenite of these steels.

Small specimens of the alloys which were prepared from the ingots as cast, and also from bars after forging and homogenizing, were quenched from various temperatures and a photographic record of the time-temperature relationship during the quench was obtained by means of sensitive string galvanometer apparatus. The cooling time or rate thus determined was correlated with the structure produced in the quenched specimen.

Since the hardenability of most steels is influenced by the size of the grains at the time of quenching, a determination was made of the grain size established at the quenching temperatures of each alloy and steel used in the critical cooling-rate and end-quench tests. The general trend was for the hardenability of the alloys, without and with boron, to increase (critical cooling rate decreased) as the size of the austenite grains increased.

To determine the primary effect of boron on hardenability, a comparison was made of the critical cooling rate of alloys of the same carbon content, without and with boron, when quenched

from temperatures sufficiently high to insure complete solution and uniform distribution of carbon in austenite of the same grain size. The effectiveness of boron in improving the hardenability of these alloys varied not only with the carbon content but also with the prior history (whether tested as cast or as forged and homogenized). With the forged and homogenized alloys, no significant improvement in hardenability was obtained by the addition of boron. With the alloys as cast, the hardenability was markedly improved by the addition of boron with carbon content of 0.3 or 0.5 per cent, but the presence of boron in the 0.7 per cent carbon alloy again had no material effect on its hardenability. The observed difference in hardenability could not be ascribed to a grain-size effect.

The results of the tests made on specimens initially as cast showed that the boron-treated alloys containing 0.3 and 0.5 per cent carbon had about the same hardenability and this was greater than that of the 0.7 per cent carbon alloy. Thus the effectiveness of boron in increasing the hardenability of these alloys decreased as the carbon content increased, that is, the improvement due to boron was very pronounced with 0.3 per cent, intermediate with 0.5 per cent, and nil with 0.7 per cent carbon.

Since boron improved the hardenability of the two alloys (0.3 and 0.5 per cent carbon) in the initial condition as cast but was practically without effect after hot-working and homogenizing, it is clearly apparent that the action of boron on hardenability was adversely affected during the course of these treatments, probably by the exposure to the relatively high forging temperature.

Boron was lost in the decarburized zone of commercial steels. Evidence indicated that the diffusion rate of boron in austenite is of the same order of magnitude as that of carbon.

The action of boron in increasing the hardenability of steel is not definitely known, but tentative explanations have been reported in the literature. These theories may be classified on the basis that (1) the improvement is due to boron in solid solution in austenite, and (2) a reaction of boron with some other element to change the condition of the latter.

The Bureau's results and those published previously support strongly the conclusion that the effectiveness of boron in enhancing the hardenability of certain steels is due entirely to its action while in solid solution in austenite. Only the portion of the boron that is in solution at the time of quenching contributes toward an increase in hardenability. The boron undissolved or in the form of compounds is either without effect, or possibly decreases hardenability by acting as transformation centers for austenite in the temperature range where pearlite is formed.

In addition to dissolving in austenite, boron can exist in steel in the form of compounds with nitrogen, oxygen, iron, and carbon. Some of these compounds are stable and are not decomposed at temperatures ordinarily used in the heat-treatment of boron-treated steels, whereas other compounds containing boron may be partially or entirely decomposed at these temperatures. Some data indicate an increase in solubility of boron in gamma iron with increasing temperature, whereas other results indicate a decrease in solubility with increasing temperature in this field. In any event, only a small amount of boron is retained in solution at heat-treating temperatures, and it is possible to obtain the maximum response in the hardenability of certain steels by minute additions of this element.

When boron enhances the hardenability of a steel, it decreases the rate of nucleation and not the rate of growth of ferrite and carbide. The boron atom, believed to be located interstitially in the gamma-iron lattice, is effective in retarding either the rate of formation in nuclei or the rate of their growth to the critical size necessary for transformation to begin, or both.

Industrial Television

TELEVISION has been given an industrial job by the Army Ordnance Department, which is using special equipment in ammunition storage areas to keep close tabs on dangerous operations.

The Ordnance Department has the task of storing and caring for several millions of tons of bombs and artillery ammunition. As part of that job, the Department works continually on large numbers of shells and bombs, removing fuses and high-explosive boosters or completely disassembling them. The danger involved in this work is obvious, since deterioration with age, weathering, or other factors have their effect on any high-explosive missile.

Since 1942, heavy concrete barricades have been prescribed for the protection of personnel in all ammunition disassembly areas. The operators work behind these barricades, manipulating various tools by remote control to disassemble the Ordnance missiles. To enable the engineers to watch this manipulation, early experiments were made with mirrors. These proved unsatisfactory because the mirrored images of the explosive items were not clear to personnel stationed at safe distances behind the barricade.

In 1943 an attempt was made to obtain a television device which would transmit by cable to a safe distance a close-up view of the disassembly operations. This search led to the selection of the Vericon television system, which transmits its impulses over a coaxial cable. The camera, receiver, and power unit are portable and require no expert technicians to handle them. Generally, the image produced is clearer than that of commercial television because there is no static interference. Of particular importance to the Army is the fact that the equipment is relatively inexpensive.

The Vericon system is in use at seven ammunition disassembly plants of the Ordnance Department. Six more are under construction. Installation is fairly simple, the camera being mounted on a tripod or other mount on the danger side of the barricade and focused for a close-up of the work under way. It would be the only casualty in case of an explosion at that point.

It is possible for a single camera to transmit identical images to as many as 10 different viewers located at different points. The pulse power generator can be located as far away as 100 ft from the camera. A viewer may be as much as a mile away from the master viewer, which can be set up as far as 1000 ft from the camera.

Rocket-Jet Airplane

WHAT is believed to be one of the first flights ever attempted under dual rocket and jet power was made recently by the D-558-2 Skyrocket, the Navy Department's Bureau of Aeronautics revealed. The research craft took off from the desert runways of Muroc, Calif., test base.

After exhausting its rocket fuel, the Navy test ship continued upon a routine research flight and landed under turbojet power.

For the past year the Douglas-built explorer has made numerous routine research flights powered by its turbojet while awaiting final development of the jet-rocket engine recently installed.

Designed and developed for the Navy by Douglas Aircraft Company, Inc., in co-operation with the National Advisory Committee for Aeronautics, the Skyrocket is obtaining valuable knowledge on advanced power plants and speeds near the sonic range of flight.

The D-558-2 Skyrocket is the advanced sequel to the Navy's D-558 Skystreak, straight-winged red jet which in the course of its research investigations broke the world speed record twice within five days in August, 1947.

Though of advanced aerodynamic design and incorporating the latest power plants, the Skyrocket performs as a conventional aircraft taking off and landing under its own power.

UNSCCUR

MORE than 450 outstanding world scientists, engineers, and technical experts from 30 countries have now accepted invitations to prepare papers for the first scientific conference to be held by the United Nations. See MECHANICAL ENGINEERING, May, 1949, p. 412.

The acceptances were in response to personal invitations sent by the Secretary General and to invitations sent to governments asking for selection of outstanding scientists.

The invitations asked for the preparation of papers on specific phases of the conservation of resources. They are to be submitted to UNSCCUR—the United Nations Scientific Conference on the Conservation and Utilization of Resources, which opens a three-week session on August 17 at Lake Success, L. I., N. Y.

Thus far, 231 scientific papers have been received. They all contain technical information for using the planet's wealth to enrich man's living standards, one of the main themes of UNSCCUR.

Most of the documents are based on experiments or long-practiced experience in resource use in the countries where the author has been carrying out work in his specialty.

Several papers have been received on "Increasing Mineral Resources by Discovery."

One paper declares that "developments in aviation and electronics in recent years have made it possible to realize the prospector's dream of geophysical exploration from the air and this has revolutionized the prospecting technique so that a new exploration routine is gradually working itself to the fore.

The author of this paper, Mr. Hans Lundberg of Canada, suggests that these methods be utilized by trained geologists and geophysicists to cover large territories in hitherto unexplored portions of the globe. Such surveys, he says, can be done in one hundredth to one two hundredth of the time required for the same work on the ground.

Another paper on this subject declares that a favorable future for the discovery of new gold deposits exists in Australia through the use of new techniques in geochemical exploration and other modern developments such as the magnetometer. In this paper Dr. H. G. Raggat, director of the Australian Bureau of Mineral Resources, also warns of the exhaustion or serious depletion of the reserves of major metals within the next 50 years. He then states his belief that science is equal to the challenge of depletion and urges governments to encourage and facilitate the interchange of ideas and techniques among nations as one means of combating this danger.

Several papers have been received which describe techniques for better means of harnessing comparatively unused natural resources.

Experiments aimed at establishment of a thriving seaweed industry in Britain are described in one paper by Major Philip Jackson, deputy director of the Scottish Seaweed Research Association. He presents three possible methods for solving the present economic problems standing in the way of large-scale underwater harvesting of seaweed. Aerial photographs, echo-sounding devices, and underwater grappling mechanisms are among the techniques described by Major Jackson in this paper.

The possible danger of depletion of certain natural resources runs like a thread through virtually all the papers received thus far. Yet specific ways and means of overcoming this danger are presented in a variety of forms each consistent with the special background of the area concerned.

Thus, Yrjo Ilvessalo, of the School of Forestry, University of Helsinki, Finland, describes aerial techniques and special methods for national surveys of forest reserves in his country. Boleslaw Krupinski, chief technical director, Central Coal Board of Poland, tells of the system of mining prevailing in the Polish Silesian coal basin.

Research Center

THE new Johns-Manville Research Center was dedicated at Manville, N. J., on May 24 by Governor Alfred E. Driscoll of New Jersey, "to service through science for better homes and greater industrial efficiency."

Several hundred scientists, engineers, builders, diplomats, and editors and publishers took part in the dedication and tours of the research facilities.

They inspected the four buildings of the new Research Center, located on a 93-acre tract on the Raritan River, about 40 miles from New York, N. Y. In the course of the inspection, the visitors saw research scientists at work on the more than 400 lines of Johns-Manville building and industrial products. In the Center, research activities are devoted to the improvement of existing products, and the development of new products to meet new needs and demands of industry and home owners and builders.

The laboratory was described as one of the largest facilities in the world devoted to research and development of building materials, insulations, and allied industrial products. The laboratories have relocatable walls, flexible built-in services, and product-development areas that include as many as 10 pilot plants under one roof in close proximity to the laboratories associated with their products. This arrangement permits close co-operation of scientist-technician "teams" from idea to commercial production.

The following three current projects illustrate the nature of basic research at the Center: First is a study of the fundamental causes of brake noise, or "squeal." Many efforts have been made to cure this noise, by all sorts of methods. Attempts have been made to redesign the braking mechanism, to load it or to damp it, or to alter the formulation of the brake lining or of the brake block. The belief of basic research personnel at the Center was that the history of these "hunch" methods indicated that a solution could be obtained only by understanding the fundamental physics of the problem. In order to simplify experimental work, a small model was built in which a tiny section of brake lining about $^1/_2$ in. wide and 1 in. long rubs against a typical cast-iron surface. By means of a mechanical vibrator this block is driven back and forth across the iron surface with a cyclical motion. Wire strain gages are used to measure the forces generated, and a visual record is obtained by means of a cathode-ray oscilloscope.

In any such problem, the first step is the duplication of the phenomenon involved and the ability to reproduce it at will. This problem was successfully solved. In fact, several different typical forms of brake squeal have been identified. The basic nature of the excitation has been established and the mathematical theory worked out. It is now possible to state in general terms what causes any form of brake noise.

Another basic problem that has received considerable attention is the mechanism of heat transmission through thermal insulating materials. A great deal of information was already

available on the thermal conductivity of a wide variety of materials. With this information, an accurate engineering job could be done in the application of these materials. It remained, however, to establish the basic reason for the superiority of one material over another, and, in particular, to be able to predict how materials behave at different temperature ranges and in the presence of different heat-transfer mechanisms.

In order to understand the mechanism of heat transfer, it is necessary first to know whether the transfer occurs by conduction, by radiation, or by convection. Since the mode of transfer is governed to an important degree by the temperature or by the temperature gradient, it is useful to conduct experiments at exceedingly low temperatures. Apparatus has been built which will measure heat transfer through insulations at temperatures as low as —300 F.

Conduction and convection vary with air density. For this reason, the apparatus was also designed to accommodate a large range of pressures. Experiments have been conducted to date at pressures down to 0.10 mm of mercury. This work is still in its early stages, but enough has been done already to show that some of the commonly accepted theories on heat transfer will require modification in order to account for the results obtained.

Still another important field of basic research at the new Center is in the chemistry of Portland cement. It is used in the numerous asbestos-cement products: shingles, boards, sheathings, and pipe. Because these products must be made to close manufacturing specifications, accurate control of cement hydrolysis is of vital importance. Under the guidance of the various interested development sections, a long-range program has been established to study the chemistry of these reactions.

The initial undertaking is to determine and to be able to identify the chemical compounds formed under various conditions of cure. Fortunately, a completely equipped x-ray-diffraction laboratory has long been a laboratory facility. Since nearly all of these chemical compounds are crystalline in nature, identification by x-ray diffraction is readily possible. However, standard x-ray diffraction patterns are not available for the identification of the cement ingredients. It is, therefore, necessary to synthesize these ingredients by laboratory means, and to prepare samples of sufficient purity so that the characteristic pattern may be obtained. Apparatus has been constructed for this purpose and certain compounds have been successfully prepared.

A long-term program of research will be involved before all of the possible chemical combinations and conditions of cure can be examined. However, when this has been done it will be possible to utilize completely the potential strength of Portland cement and thus produce a stronger, tougher, lighter, line of asbestos-cement products.

Parachute Testing

An investigation has been conducted to determine the opening characteristics of several hemispherical parachutes at air speeds up to 200 mph, and is reported in National Advisory Committee for Aeronautics Technical Note No. 1869 by S. H. Scher and L. J. Gale of the Langley Aeronautical Laboratory, Langley Air Force Base, Va. The influence of the parachute design variables on these opening characteristics was also studied.

Before some types of airplanes are accepted by the Armed Services, the contractor is required to assure by flight tests that the airplane will be satisfactory in recovery from a spin. During the spin demonstration flights the airplane is usually

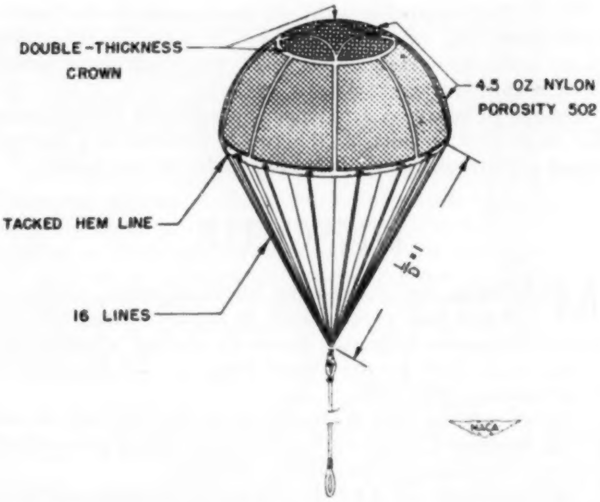

FIG. 8 ONE OF THE PARACHUTES—30-IN-DIAM—USED IN TESTS

equipped with a tail parachute for use as an emergency spin-recovery device. In the past, flat-type parachutes made of silk or nylon such as is conventionally used in personnel-type parachutes have been successfully used to effect spin recovery both in flight and with dynamically scaled-down airplane models in the Langley 20-ft free-spinning tunnel. The use of conventional parachutes has been objected to, however, because their inherent instability causes dangerous pitching and yawing gyrations of the airplane when opened during level-flight check runs prior to the spin demonstration flights. Unpublished results of a recent NACA investigation indicate that a stable rather than a conventional parachute would be desirable for use as an emergency spin-recovery device. In connection with the afore-mentioned investigation it was noted that although the stability of a parachute could be improved by increasing the porosity of the fabric in the canopy, the opening characteristics of the parachute might be affected adversely, that is, the parachute might not "blossom" fully immediately upon being opened and its maximum potential drag would therefore not be obtained to effect rapid spin recovery.

For the present study, a parachute manufacturer made available to the NACA seven types of hemispherical parachutes. A feature of the design of some of the parachutes was a strip of low-porosity material in the canopy area just above the hem line which the previously mentioned investigation had indicated would be beneficial to opening characteristics. Each of the hemispherical parachutes differed somewhat in design and an attempt was made to evaluate generally the effects of shroud-line length, fabric porosity and weight, and hem-line construction upon opening characteristics. Tests were also made to determine the effects of some of these design variables on the drag and stability characteristics of the hemispherical parachutes.

Tests to determine the opening characteristics of the various hemispherical parachutes were made in the Langley 300-mph 7 × 10-ft tunnel, which is a horizontal atmospheric wind tunnel. Tests to determine the drag and stability characteristics of the parachutes were made both in the Langley 300-mph 7 × 10-ft tunnel and in the Langley 20-ft free-spinning tunnel. The Langley 20-ft free-spinning tunnel is a vertical atmospheric wind tunnel with a vertically rising air stream.

The parachutes used in this investigation had preformed hemispherical canopy shapes. See Fig. 8. The porosities for the material in the parachutes were obtained from the manufacturer and are defined as the cubic feet of air that will pass

through 1 sq ft of the cloth per minute under a pressure of $\frac{1}{2}$-in. of water. The weight of the nylon indicates the approximate weight of 1 sq yd of the cloth. The parachutes were constructed with floating hem lines. During many of the tests the hem lines were tacked to prevent the hem-line loops from pulling out and thus distorting the parachute shape during opening.

For testing the opening characteristics in the 7 × 10-ft tunnel, the packed parachute with its towline was fastened to a cable which in turn was fastened to the tunnel balance scale. When an air speed of about 200 mph was attained, the pack was opened from outside the tunnel by pulling a chord attached to a pin which held a canvas restraining wrapper on the parachute pack. The ensuing action of the parachute was then observed and motion pictures were made of the tests.

For the parachutes which blossomed fully when opened in the 7 × 10-ft tunnel, drag-force measurements were made for an air speed of 200 mph. In the 20-ft free-spinning tunnel, the drag of the parachute was determined from free tests during which the fully blossomed parachute supported a small spherical weight in the vertically rising air stream. The drag of the parachute was then taken to be equal to the sum of the weight of the parachute and the suspended weight. The drag coefficients calculated were based on the projected area of the hemispherical canopies. The tunnel air speed during these tests was approximately 17 mph.

The stability of each parachute which blossomed fully at 200 mph in the 7 × 10-ft tunnel was determined by observing its behavior at this speed. Also, the stability of each parachute was determined at a speed range from 30 to 46 mph for the fully blossomed parachutes which were fastened to a horizontal bar in the 20-ft tunnel. At a given air speed, parachutes which aligned themselves with the air stream or which inclined no more than a few degrees (3 or 4) from the air stream and did not oscillate were considered stable.

On the basis of the test results, the following conclusions and recommendations are made:

1 Some of the parachutes blossomed fully in the air stream if their hem lines were tacked.

2 In general, beneficial effects on hemispherical parachute opening characteristics were obtained when greater shroud-line length as compared with parachute diameter was used, when the floating hem lines were tacked to prevent the hem-line loops from pulling out under load, or when a strip of low-porosity fabric was provided around the canopy in the area immediately above the hem line.

3 The drag characteristics of the parachutes were not appreciably affected by changes in shroud-line length, by tacking of hem lines, or by use of a low-porosity-fabric strip above the hem line.

4 The stability characteristics of the parachutes were affected somewhat adversely by the use of the low-porosity fabric just above the hem line.

5 For a given parachute, increased air speeds generally impaired opening characteristics, decreased the drag coefficient, and improved the stability.

6 Proposed parachute designs should be checked by testing of full-scale parachutes at the desired air speeds before being selected for a specific use.

Motion pictures of the opening characteristics of the parachutes were obtained during the tests and are available for loan upon request from NACA Headquarters, Washington, D. C.

Pump Testing

A NEW centrifugal-pump test floor which is said to contain the most efficient and accurate commercial-pump test facilities ever developed, has been put into service at the West Allis works of the Allis-Chalmers Manufacturing Company recently.

Designed to provide for both maximum testing accuracy and minimum testing time and expense, the new facilities will be of great importance to the company's long-standing policy of obtaining and maintaining on file complete performance data on every pump it builds. Reduction in test time will aid in improving shipment time on pump orders, while the obtaining of materially more accuracy data is expected to prove of great value both to pump designers and pump users.

The modern facilities include some new applications of equipment and some devices designed and built especially for this application. Most interesting of the latter is a speed-measuring device, believed to be the most accurate mechanism ever built for continuously measuring and recording speed. It is used in conjunction with an electric strain-type torque meter to obtain the horsepower input into a pump, a method which is simpler and more accurate than the common method of of measuring the input with a calibrated motor.

New equipment for measuring quantity of water pumped involves the use of weigh tanks rather than weirs. Besides

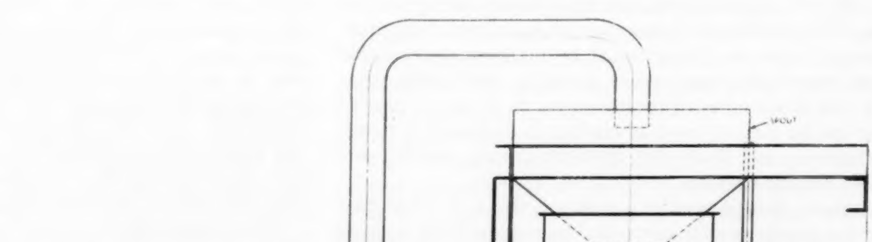

FIG. 9 OUTLINE DRAWING SHOWS COMPLETE TEST STAND, INCLUDING PUMP, MOTOR, WEIGH TANK, AND SCALE

permitting more accurate readings, this method makes possible the taking of test points automatically, by means of a photoelectric cell which "reads" the weigh-tank scale. Motor speed, torque, and pump discharge and inlet pressure are all recorded continuously during the test period, the recording meters and test timers being controlled by the photoelectric circuit.

The material reduction in the time and labor required to make tests is obtained by means of greatly simplified set-up procedure. Permanent test stands with movable individual hydraulic-powered motor and pump pedestals permit the operator to line up pump and motor quickly and simply by means of control levers, eliminating tedious shimming and shifting the motor around by hand. Suction and discharge piping, designed for easy connection to the pump flanges, is made of aluminum so that it can be handled easily without need for hoists or cranes. Pressure-meter connections simply plug in. Since the multi-horsepower, multispeed motors on the stands cover a wide range of speeds and horsepowers, motors will rarely have to be interchanged. Thus connections to meters and to the power source do not have to be changed for each test, which was formerly the case. These various features are expected to cut the time and labor required for testing by at least 60 per cent.

Though the primary use of the new facilities will be for commercial pump tests, the data taken will be of value in improving pump design, and it is planned that some research work will also be done.

Magnetic Fluids

THE magnetic fluid originally used in the electromagnetic-fluid clutch (see MECHANICAL ENGINEERING, May, 1948, p. 442) developed at the National Bureau of Standards, Washington, D. C., has several unique features that make possible other important applications of the iron-oil mixture.

The basic property on which all applications depend is the viscosity of a magnetic fluid being directly related to the strength of the applied magnetic field. The fluid may be changed from a liquid to a nearly solid state and back again at will. In some applications, extreme fluidity is required at all times, while in others a thixotropic characteristic is needed. (Thixotropic fluids are characterized by isothermal reversible gel-sol-gel transformations under shearing and subsequent resting.) Further studies of the magnetic fluids have revealed that they can be used to good advantage in hydraulic systems, shock absorbers, and dashpots; to form casting molds; and as variable electric resistors.

If a magnetic fluid is used in a dashpot, the rate of motion of the piston can be readily controlled by magnetically varying the viscosity of the fluid. If a coil of wire is placed around the dashpot, the viscosity of the magnetic fluid will be a function of the current in the coil. Employing this idea in the design of shock absorbers for automobiles and trucks would provide an adjustable riding quality to meet various loading and roadway conditions. The rate of response of the magnetic fluid is high enough to provide virtually instantaneous changes in viscosity, thereby making possible a shock absorber with automatic compensation.

By winding a coil of wire around a fluid-carrying pipe and controlling the amount of current through the coil, the flow of fluid past that point can be closely regulated from full flow to complete cut-off. In this manner, various points in a hydraulic system can be remotely controlled from a central station.

For use in molding operations, a magnetic fluid is placed in a pot surrounded by a current-carrying coil, a model of the part to be cast is placed in the fluid, and the coil is then energized so that the fluid will solidify around the model.

An electric resistor adapted to remote control can be made by immersing two electrodes in a magnetic fluid.

The success or failure of any device utilizing magnetic fluids will depend to a considerable extent on the particular components in the iron-oil mixture, the choice of suspension fluid and iron powder in large measure being determined by the application for which the mixture is intended. The iron powder is one component of the mixture not generally varied from one application to another. Carbonyl iron in the form of particles about 8 microns in diameter has proved most successful.

On the other hand, the choice of the suspension fluid must take into account chemical stability, flammability, vapor pressure, and viscosity. One type of fluid that the Bureau found satisfactory is a silicone liquid that has a viscosity of about 50 centistokes at 25 C. It is excellent with respect to non-flammability and vapor pressure and this versatile liquid will serve satisfactorily in nearly all but extremely high-temperature applications.

Two Out of Three

IN scientific and engineering investigations if three measurements are made, it is fairly common practice for students to take the "best two out of three"—averaging the two values closest together and discarding the other. Recently, however, Dr. W. J. Youden of the Statistical Engineering Laboratory at the National Bureau of Standards has shown that this procedure very often leads to less precise results than the averaging of all three measurements together.

Experimental work frequently creates new situations in which the precision of the observations is not known in advance and must be determined from the same data that establish the estimated or average value assigned to the quantity being measured. While a single measurement cannot yield any estimate of the reproducibility of the value, two measurements do give a primitive indication of their precision. But in an entirely new experimental situation, Dr. Youden points out, two measurements may not give a reliable estimate of the precision, since any marked disagreement between the two readings may be due either to the inherent crudeness and inaccuracy of the measurement process or to some accident, such as the gross misreading of an instrument scale, which makes at least one of the measurements greatly in error. With two discordant observations and no other information, it is impossible to decide between these alternative interpretations.

Three measurements is the minimum number that can conceivably reveal one of the measurements to be unreliable in a new experimental situation. Intuition suggests that if two of the three measurements are in close agreement while the third stands apart considerably removed from either of the others, then there may be grounds for suspecting and perhaps rejecting the third value. In terms of the difference between the two in good agreement, how different may the third measurement be before it should be suspected? Since this problem is important to all who make and interpret measurements, it is a little surprising that an answer has only recently been found.

An approximate solution has been obtained in the Bureau's Statistical Engineering Laboratory through an empirical study of triads drawn at random from a large group of measurements constructed to conform to the characteristics of a normally distributed set entirely free from any gross errors. In this way it is possible to examine a great many sets of three measurements and to determine, for example, how often the two differences

between adjacent values in a set of three measurements will bear a ratio of 5 to 1, 10 to 1, 20 to 1, or any other ratio that might be considered unlikely in the normal course of events. If only 1 out of 100 sets of three measurements contained a measurement differing from the others by as much as five times the difference between the two closest, then such an observation might reasonably be discarded in actual experimental data. But the empirical study actually showed that a rather unbalanced spacing between three measurements occurs quite frequently. In fact, the ratio of the two differences was as much as 16 to 1 in 10 per cent of the sets of three measurements. In this connection, it is important to note that the high ratios can result when two of the readings are very close or coincident while the third is not far removed.

The mathematical solution of this problem has been obtained and the frequency of occurrence for various ratios of the two differences has been calculated. The following table shows for certain ratios the results of an empirical sampling study of 400 sets of three measurements compared with those predicted by the exact mathematical solution of the problem.

Ratio of large to small difference	Frequency in 400 sets	Theoretical frequency
4.0 or more	149	145.2
9.0 or more	76	69.4
19.0 or more	38	33.9

These results reveal that in an average of one out of every twelve sets, one of the measurements will be at least 19 times farther away from its neighbor than the difference separating the two closest. Since in every 12 sets 1 shows such a spacing for measurements with no gross observational errors, it appears that measurements which should be retained are often dropped from the record. The problem of deciding on standards for the rejection of observations is one of long standing. Statisticians are again attacking this problem, and in the light of recent advances in the theory of small samples, considerable progress can be expected.

Education and ECA

EDUCATION and training must have first place in any program of world recovery if the program is to be recovery and not relief, Paul G. Hoffman, administrator, Economic Cooperation Administration said recently in an address before The American Council on Education, in Washington, D. C.

He stated that if the productivity and hence the standard of living of the free people is to be increased, it can come about only through the enlarged use of training—training not only in production techniques but training in attitudes. The attitudes of both management and workers toward their jobs is one of the controlling elements in working out problems of increased productivity.

As for education, if while learning to make a better living, the people do not, at the same time, learn how to live a better life, there will not be much substance to whatever gains ensue.

Some details of the educational assistance ECA is giving the Marshall Plan nations through its technical assistance program were given by Mr. Hoffman. In general, the aim of the program is to enable the ECA countries to increase productivity, both industrial and agricultural, through more effective use of their own resources and ECA-financed goods and services. Obviously, increased production is the keystone of economic recovery. Since in practically all the countries ECA is serving—all, in fact, but Germany and Italy—lack of man power is a problem; this means increasing output per man-hour rather than merely increasing the labor force and adding more machines. It means increasing the efficiency of both the workers and production facilities. Such a method can be both time and dollar saving. A relatively small sum, spent wisely, may do the work of a much greater amount used to finance imports.

Under the technical assistance program, Mr. Hoffman said, we have brought responsible operating officials from electric power plants in the ECA countries to study the methods we use to reduce outage. The dollar cost will be nominal—something around $50,000—but it can result in increased capacity which would cost millions—if not hundreds of millions—as well as time, to build.

Increased power means increased industrial output. Recent studies of European production have disclosed that industrial production per man-hour in the United States is about $2^1/_2$ to 3 times as great as in Europe. This is not of course just a natural phenomenon, due to climate or some other and unexplainable factor. Neither is it necessarily due to the high I.Q. of American workers. The European worker, in most cases, is just as capable, just as ambitious.

ECA and the ECA nations proposed to find out the "why" of high American productivity and, wherever possible, to translate that why into European terms.

To that end ECA is sending expert consultants to Europe. The ECA nations, as in the case of the electrical engineers, are sending teams of both workers and experts to this country; an exchange of technical experts between the ECA nations is being arranged and technical literature (special studies and surveys) is being distributed. One of the results of the program has been the discovery on this side of the Atlantic that European workers and experts have much to contribute to our own industrial knowledge. Rather than merely providing know-how the program has proved to be an exchange of ideas.

Increased production in the field of agriculture is another feature of the technical assistance program. Studies have revealed that an increase of 5 per cent in European agricultural production would cut import requirements by a billion and a quarter dollars. In general, the program will show results more over the long range than in the immediate future but in some instances returns now seem to be on the books. By way of illustrations, thirty-three young farmers from the Netherlands arrived in the U. S. April 7. They are living with American farm families in 14 states from Maine to Wisconsin, learning, through actual work experiences, American farm methods. They will have on-the-job training in animal husbandry, farm mechanization, stock and crop-disease control, pest and weed control, and 4-H Club work. On their return to the Netherlands, they will pass on to other Dutch farmers what they have learned.

Two forestry experts from Norway and a wood research expert from the Netherlands are now in this country, beginning a three months' intensive study of American methods and techniques. They will visit forestry experimental stations, forest-products factories, botanical laboratories, and similar installations from coast to coast. Among the subjects to be studied are the use of wood waste, gluing processes in making plywood, painting, fireproofing and preservation of wood, and control of termites and marine borers. Techniques on all these subjects in the U. S. are far advanced over those of Europe.

To date some 200 different teams are scheduled to visit the United States during the coming year. The following are a few examples: A 16-man team from the British rayon-weaving industry; two Greek government engineers for a two months' study of U. S. reclamation projects; six Norwegian technicians to investigate mining, manganese production, steelmaking, and pulp and paper production; a three-man Italian labor team to study industry and labor conditions.

There is also the Anglo-American Council on Productivity. This is a permanent setup, established, however, under ECA's technical-assistance program. It acts as a clearing house of

production information between this country and Great Britain and has already sponsored the visit of one group to this country—a team of foundry management personnel and workers. Other such visits are scheduled.

On the other side of the picture, an American scientist and an insecticide expert are leaving shortly to study African sleeping sickness and malaria in East and West Africa. Their job will be to make recommendations for further U. S. assistance in combating the tsetse fly and mosquito, carriers of the two diseases.

He pointed out that genuine European recovery cannot be achieved in a vacuum. Its success is contingent upon balanced economic relationships with the rest of the world. The underdeveloped dependent areas of the ECA countries offer possibilities for bringing about a greater degree of well being and a better balance in the world economy, with relatively small investments of capital.

Supersonic Wind Tunnels

A NEW 16-in. × 16-in. intermittent-flow-type wind tunnel for research on high-speed aircraft and guided missiles at speeds exceeding Mach 5 has been completed by North American Aviation, Inc., Los Angeles, Calif., according to the CADO *Technical Data Digest*, May 15, 1949. The firm has been operating a smaller continuous-flow supersonic tunnel for velocities up to 2700 mph for three years, but this new instrument is now the largest supersonic tunnel operated as a private research investment by America's aviation industry. Cost of the new tunnel was $286,000.

Basic design of the North American tunnel is patterned largely on those erected by the Germans at Kochel in 1937. The Kochel tunnels were dismantled and shipped to the United States where they attained a speed of Mach 5.19 at the Naval Ordnance Laboratory, White Oak, Md.

In the intermittent-flow tunnel the test section is interposed in a duct between a large vacuum chamber and a dry-air storage tank, with the flow from one to the other being controlled by a quick-acting gate valve. While the vacuum chamber is being emptied, the air-storage tank is being charged with dry air. When the gate valve in the tunnel duct is opened, dry air from the storage tank is forced by atmospheric pressure into the vacuum chamber at high velocity.

A Venturi-shaped throat is formed immediately ahead of the model by inserting hardwood nozzle blocks in the ducting of the test section. These nozzle blocks can be varied in cross-sectional profile and throat diameter to provide air speeds ranging from Mach 1.2 to Mach 5.3 at sea level.

Although the intermittent-flow-type tunnel provides a short test period (15–20 sec), very little power is expended. For example, a 99.8 per cent perfect vacuum can be obtained in $37^1/_2$ min by the use of a pair of 200-hp motors, each unit of which drives a pair of two-stage vacuum pumps.

It has been found that this short test period is adequate because all aerodynamic forces and moments are automatically recorded by strain gages connecting the spring balance of the model to recording machines. A visual picture of the shock-wave pattern is provided by using a Schlieren optical system, which not only produces a film record but also throws the image on an outside screen for observation of the flow during the test run.

Another new supersonic wind tunnel, built with Office of Naval Research funds, has been placed in operation at the University of California. It is reported to be the first designed to develop supersonic speeds under conditions found at 50 to 80 miles above the earth.

The project was begun in 1946 and has been made possible chiefly because of the progress made in vacuum and jet-pump development during the war. It will permit the study of fluid mechanics at speeds beyond the reach of present tunnels.

It is estimated that the new tunnel is capable of creating speeds four times the speed of sound in pressures 100,000 times less than atmospheric. A steam-jet vacuum-pump system consisting of five stages of pumps requiring 3,500,000 Btu per hr to operate, creates the extreme low pressures in the tunnel.

Man-Made Rainforests

A MAN-MADE "tropical rainforest" which simulates the most severe climatic conditions of the deepest jungle, is enabling the Army Signal Corps to lengthen the useful life span of sensitive communications equipment, it was disclosed by the Department of the Army recently.

The rainforest—meteorologists' term for the humid jungle—can produce in the test chambers of the Signal Corps Engineering Laboratories at Fort Monmouth, N. J., conditions ranging from a fine fog mist to a teeming tropical torrent of two inches an hour. Its temperature and humidity controls, capable of sustaining a maximum of 190 F at 100 per cent humidity, plus heavy condensation, accelerate growth of fungi and corrosion on exposed equipment much as if it were rapidly rotting in the jungle.

Because of the tropical room's proximity to the Signal Corps arctic chambers also located at Fort Monmouth, where man-made snowfalls can be produced in a matter of minutes, it is possible to subject materials to both extremes of temperatures with minimum time and thus accelerate one of the Signal Corps' most important peacetime missions—testing the performance of American signal equipment under conditions that might be encountered anywhere in the world.

Conditions within the chamber are so realistic that extraordinary health and safety precautions are necessary to safeguard those working within from exposure to high humidities, temperatures, and other dangers. Operators must all but live in a jungle, while persons with the slightest history of malaria or heart disease, for example, are forbidden access while a test is in progress. To prevent loss of weight and "light-headedness" as the result of extended exposure to the sweltering heat and humidity, persons assigned to the rooms require frequent rest periods.

Each of the six rooms making up the laboratories' tropical wing is connected to an automatic coal-mine-type detector for carbon-monoxide and inflammable gas which may result from the tests. All electrical work is explosion-proof and an emergency switch is located near the door which transmits distress signals throughout the building should an accident occur during a hazardous test procedure.

The tropical test rooms operate from a minimum dew point of 37 F to approximately saturation at dry-bulb temperature of from 40 to 190 F. The main chamber, largest of six in the tropical wing, measures 30 ft long, 18 ft wide, and has a 14-ft ceiling. Its size is sufficient to permit a General Sherman tank, or a vehicle loaded with a field radar set, to drive in and out. A system of elaborate automatically operated conditioning devices transmits the required heat and humidity into the room.

Using wartime experiences and a Signal Corps postwar survey of communications equipment as the basis for further research, use of the tropical chambers has been of notable value in finding means to extend the life of many varieties of metals, fabrics, leather goods, and electrical and electronic devices from the ravages of fungus growth and corrosion.

ASME TECHNICAL DIGEST

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Oil and Gas Power

THE following 1949 ASME Oil and Gas Power Conference papers are available as a "package" at $1.75 to nonmembers and $1.40 to members. Individual copies are also available at the usual rates.

Dynamic Analysis of Valve Springs, by Troels Warming, Jun. ASME, University of Wisconsin, Milwaukee, Wis. 1949 ASME Oil and Gas Power Conference paper No. **49—OGP-1** (mimeographed).

Helical springs behave much like a long freight train being started. As the locomotive pulls ahead one can hear the slack in the couplings gradually being taken up down through the train. Similarly, when you move the end of a spring, the first coil moves first, a little later the second coil, then the third coil, and so forth. The movement progresses as a sound wave through the spring.

On slow-running machinery this wave will travel so fast, relatively, that for practical purposes one may consider that all the coils move in unison. The spring force then is the same in all the coils, and it is proportional to the change in length.

On high-speed machinery, however, the spring force may vary considerably from coil to coil. This has two important effects: (1) The spring force at the end will not equal the spring scale times the over-all change in length. It may be considerably higher or lower than this value. (2) Serious surges may be set up which may cause spring breakage.

The natural frequency of helical springs, dynamic spring force, wave progression and reflection, uniform acceleration cam, sine cam, and spring surge are discussed.

Vibrations in Valve Mechanisms, by Troels Warming, Jun. ASME, University of Wisconsin, Milwaukee, Wis. 1949 ASME Oil and Gas Power Conference paper No. **49—OGP-2** (mimeographed).

At the no-follow speed for a valve mechanism the roller will leave the cam. This speed may be determined by calculation or by experiment. The calculation considers the lift-curve acceleration, the weights of the moving parts, and the valve-spring characteristics. The experiment is based on the noise when the roller comes back to the cam.

Unfortunately there is often considerable disagreement between the values for the no-follow speed determined by these two methods. This difference may be explained by vibrations in the valve mechanism. Even when the roller stays on the cam, these vibrations are detrimental. They will increase the pressure between roller and cam thus increasing the possibility of pitting. It is important, therefore, to keep the vibrations in a valve mechanism at a minimum.

The discrepancy between the no-follow speed of a valve mechanism as determined by calculation and by experiment is explained by vibrations in the valve spring and in the push rod. Abruptly changing lift-curve acceleration will cause severe push-rod vibrations, while uniformly changing acceleration is beneficial. The ramp causes additional complications. A complete set of the calculations necessary to design a lift curve is given.

Effect of Cylinder Pressure Rise on Engine Vibrations, by J. O. Hinze, Royal Dutch Shell Oil Company, Delft, Holland. 1949 ASME Oil and Gas Power Conference paper No. **49—OGP-3** (mimeographed).

This paper shows that it is fundamentally impossible to express the effect of the particular shape of the pressure-time curve on the response of the vibrating system in terms of one single time derivative of the pressure-time curve, for the same reason that it is fundamentally impossible to express the particular shape of the pressure-time curve in terms of one single derivative.

It appears that some fundamental features of a force-excited simple harmonic oscillator may be successfully applied to engine vibrations originating from the pressure rise in the cylinder. If the applied force is periodic and shows a rather short period of rapid rise compared with the natural period of the oscillator, vibrations are generated each time the rapid rise sets in. If damping forces are present, of the order of magnitude as occurring in actual cases of engine vibrations, the analysis can be appreciably simplified by considering only one single period. The actual vibration problem may then be approximated by studying the transient vibrations of an oscillator excited by a force that shows a rapid rise during a certain time.

From the analysis of this simplified problem it is concluded that in analyzing pressure-time curves of internal-combustion engines for their effect on engine vibrations, the following must first be determined: The ratio between the period of rapid pressure rise and the natural period of the vibratory system; further, the maximum pressure rise during the former period over and above the compression pressure. Only if this ratio

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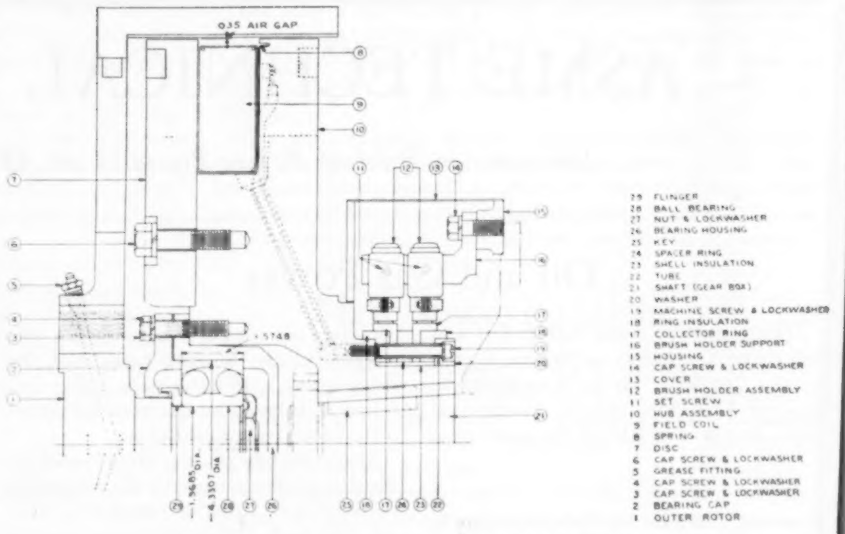
exceeds a value of 0.25, roughly, is it worth while to analyze the shape of the pressure-time curve more closely for its effect on the response of the vibratory system. It must be kept in mind, however, that the effect of the shape of the pressure-time curve still is a minor one if compared with the effect of the duration of the period of rapid pressure rise.

To judge pressure-time curves on their vibration-exciting features only a rough measure can be given, which then must be in terms of the following: The ratio between the period of rapid pressure rise and the natural period; the total pressure rise in this period; and in some cases also in terms of the rate of pressure drop beyond its maximum value.

Application to some cases found in literature shows that the theoretical features derived for a harmonic oscillator are satisfactorily applicable to actual vibratory systems.



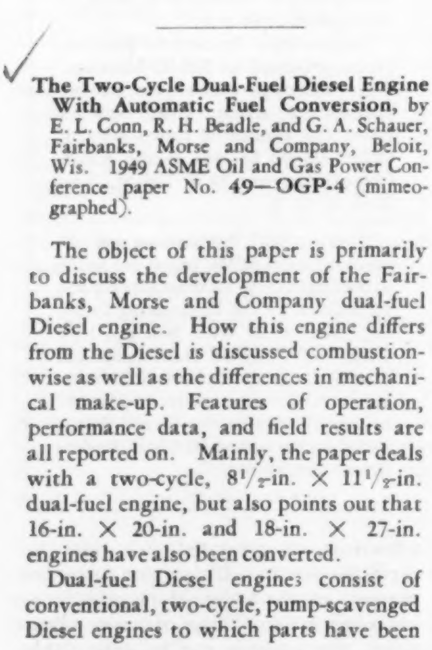
LONGITUDINAL SECTION OF EDDY-CURRENT CLUTCH

The Two-Cycle Dual-Fuel Diesel Engine With Automatic Fuel Conversion, by E. L. Conn, R. H. Beadle, and G. A. Schauer, Fairbanks, Morse and Company, Beloit, Wis. 1949 ASME Oil and Gas Power Conference paper No. **49—OGP-4** (mimeographed).

The object of this paper is primarily to discuss the development of the Fairbanks, Morse and Company dual-fuel Diesel engine. How this engine differs from the Diesel is discussed combustion-wise as well as the differences in mechanical make-up. Features of operation, performance data, and field results are all reported on. Mainly, the paper deals with a two-cycle, $8^1/_2$-in. × $11^1/_2$-in. dual-fuel engine, but also points out that 16-in. × 20-in. and 18-in. × 27-in. engines have also been converted.

Dual-fuel Diesel engines consist of conventional, two-cycle, pump-scavenged Diesel engines to which parts have been added so that the engine, without benefit of operator attention, will automatically convert from gas to oil, or from oil to any percentage of gas up to 90 to 95 per cent. When running on gas, the 5 to 10 per cent of oil fuel is used to ignite and to control the ignition of gas.

The Fairbanks, Morse line of dual-fuel engines operate on the 2-cycle high-compression principle, ignition being produced by a small injection of pilot fuel which is handled by small plungers, separate from the main Diesel plunger. Gas is admitted to the cylinder through a mechanically operated valve in the head with constant timing. The amount of gas admitted to the cylinder is controlled by the pressure in the gas header by a governed throttle valve. Engines from 325 bhp to 3500 bhp are available in the dual-fuel line.



SCHEMATIC GOVERNOR-CONTROL DIAGRAM

The Diesel-Locomotive Engine Cooling System, by F. H. Brehob, General Electric Company, Erie, Pa. 1949 ASME Oil and Gas Power Conference paper No. **49—OGP-5** (mimeographed).

The design and construction of the engine-cooling system for Diesel-electric load locomotives is of great importance. Proper radiator proportions are necessary to achieve maximum over-all efficiency. The flexibility required to meet varying load conditions is usually obtained by regulating air flow through the radiator. One of the most satisfactory of the various schemes used for this purpose employs an eddy-current clutch to vary the fan speed. A comparison of popular schemes reveals that, over most of the operating range, this form of drive requires the least amount of power from the engine.

The radiator-fan-drive system for cooling the engine on a Diesel-electric road locomotive in most cases uses more power in warm weather than any other auxiliary. Therefore it is important that the entire radiator-fan system with its drive be applied in an efficient manner so as to consume the least possible power. When these optimum conditions are present, the maximum amount of prime-mover output will be available for traction. Furthermore, the radiator-fan system is important because it must provide the necessary ventilation to maintain the proper operating temperature of the Diesel engine through a wide range of ambient-air temperature and engine load.

Since the radiator is inherently a fixed piece of apparatus, the variation in cooling requirements is met by controlling the radiator-fan speed, or by having a multiplicity of fans which may be operated in varying numbers to give the desired amount of cooling. A water by-pass system for the radiator could be used to achieve this result, but such an arrangement is not generally employed on Diesel-electric road locomotives as it tends to waste auxiliary power and introduces the hazard of freezing the radiator at low temperatures.

Ignition System for Oil Engines, by H. B. Holthouse, Holthouse Laboratory, Chicago, Ill. 1949 ASME Oil and Gas Power Conference paper No. **49—OGP-6** (mimeographed).

One modification in an ignition system for oil engines which appears to give improved performance over the conven-

tional spark-ignition system is that included in the Holthouse ignition system. This system is being used on many gasoline engines and is said to be giving excellent results. Many designers and users of engines burning lower-grade fuels, however, are not aware of its possible applicability to their engines.

Test results on a Hesselman engine showed that this engine severely knocked when highly loaded with the normal ignition system, while with the Holthouse ignition system it did not knock, and the spark plugs were kept perfectly clean throughout all testing which included starting the engine on fuel oil. An idling speed of 200 rpm was obtained readily on this engine.

The test also included putting badly fowled plugs into the engine and again starting the engine on fuel oil.

Test results on another 6-cyl high-speed Hesselman engine placed in an automobile gave unusual flexibility with a low idling speed of 350 rpm up to normal maximum engine speed. This engine was also started on fuel oil and operated under all load with no smoke or odor.

The following advantages are claimed by using the Holthouse ignition system on Hesselman engines: (1) Easy starting; (2) fouled plugs are eliminated; (3) a definite fuel economy is obtained due to better combustion; and (4) increased power is obtained due to better combustion.

The improvement in the Holthouse high-frequency ignition unit has been accomplished by the addition of an air-core transformer, the primary of which consists of a few turns of heavy copper wire, connected in series with an additional condenser across the breaker points.

The secondary winding of this air-core transformer consisting of several hundred turns of wire, is connected in series with the secondary of the regular ignition coil between the high-tension terminal of this coil and the distributor. The current set up as a result of the induced voltage in the primary will now tend to charge both condensers. The current that charges the second condenser will obviously flow through the primary winding of the air-core transformer, inducing a voltage in the secondary of this winding, which will increase the total voltage supplied to the spark plug. With inductance and capacity connected in series across the breaker points, an oscillating current will be set up in this circuit and by the proper choice of the electrical constants of this circuit, the frequency of these oscillations can be selected so as to obtain maximum results in this ignition circuit.

This primary oscillating circuit induces current in the secondary, not as a single impulse, but continues with each oscillation until these oscillations are damped out. The current induced in the secondary of the high-frequency transformer by these primary oscillations is added to the output of the ignition coil secondary.

A Training Program for Railroadmen, by George Y. Taylor, American Locomotive Company, Schenectady, N. Y. 1949 ASME Oil and Gas Power Conference paper No. **49—OGP-7** (mimeographed).

The American Locomotive Company's postwar Diesel-electric training program for railroadmen is discussed in this paper.

The course is restricted to 10 actual working days of instruction in the construction, operation, and maintenance of Diesel-electric locomotives. Instruction is provided free of charge to the railroads as part of the locomotive manufacturer's service. It is limited to railroad operating men, although special courses for railroad purchasing agents and storekeepers, and for oil-company railroad-lubrication men, have been given.

On the first day the railroader students are indoctrinated into the history and development of the Diesel-electric in classroom presentations, and then conducted through an extensive tour of the Alco manufacturing facilities.

On the second, third, and fourth days, the men actually assemble a mainline Diesel engine, get the feel of the parts, and gain an understanding of function that can come only with firsthand experience. They are instructed on the technical names of parts and the roles these parts play in the operation of the engine. Maintenance instruction is an important element of this part of the course.

On the fifth, sixth, and seventh days they follow much the same procedure in regard to the operation and maintenance of the electrical equipment for the locomotive.

On the eighth and ninth days the men explore the locomotive systems for lube and fuel oil piping, cooling water, air pressure, and braking systems, and the other chassis equipment.

The last day is devoted to a study of accessories installed in the various types of locomotives, such as the steam generating plant, air brakes, and other features. A detailed inspection of a completed locomotive just out of the paint shop is also made.

More than 1000 railroadmen from 55 American railroads have attended the school.

The physical facilities of the school are also described.

Diesel-Engine Maintenance, by Stanley E. Lodge, American Locomotive Company, Schenectady, N. Y. 1949 ASME Oil and Gas Power Conference paper No. **49—OGP-8** (mimeographed).

This paper describes the procedure used in instruction of railroad personnel in the construction and maintenance of the Diesel engine used in Diesel-electric locomotives. Emphasis is placed on the design of the engine which features: (1) Interchangeability of wearing parts; (2) accessibility to all parts; (3) light parts which permit easy handling; and (4) supercharging, which gives ample horsepower in a comparatively small and light engine.

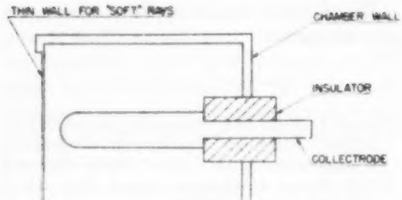
The Alco-G-E Diesel-Electric Locomotive School is primarily interested in training railroad personnel in the proper operation and maintenance of Alco-G-E Diesel-electric locomotives. When this is accomplished it will result in a higher locomotive availability and a reduced maintenance cost to the customer. In this fast transition from steam motive power to Diesel-electric motive power, the railroad machinist and electrician have found themselves confronted with something new. Their early training and lifelong work on steam locomotives did not call for the precision tools, methods, and equipment that are called upon for the maintenance of Diesel-electric locomotives. The railroads, realizing this, and not wanting to go outside their own ranks for help, have turned to education as a means for meeting this fast transition.

Radiation Instruments

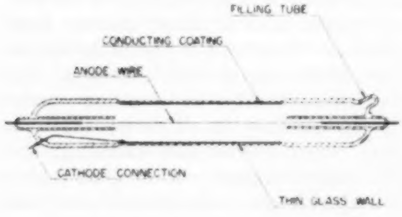
Modern Radiation Instruments for Health Protection Surveys and Monitoring, by Everett W. Molloy and Arnold O. Beckman, National Technical Laboratories, So. Pasadena, Calif. 1949 ASME Spring Meeting paper No. **49—S-25** (mimeographed to be published in MECHANICAL ENGINEERING.)

The rapidly increasing use of atomic energy and radiochemistry is demanding more and more assistance from almost all types of engineering. Although the engineer may not be directly concerned with radioactivity, the peculiar properties of radioactive elements are such that he will find a short introduction to the radioactive hazards and their detection useful. In this new field the hazards are new, their recognition difficult.

The purpose of this paper is to set forth in simple terms the physical na-



IONIZATION CHAMBER



GEIGER-MULLER TUBE

ture of the hazardous radiations and to describe the available tools used to measure them.

Alpha particles, Beta particles, gamma rays, and neutrons are the particles to be detected.

Nearly all the common radiation detectors depend on the phenomena of ionization, the simplest of all detectors, and historically the earliest, being the ionization chamber.

Geiger-Muller tubes, Geiger tubes, or G-M tubes, as they are commonly called, are also very sensitive devices and with them single electrons can be detected.

Proportional counters are in essence modified Geiger tubes, the difference being that the signal out of this detector is proportional to the initial ionization produced in the counter by the ionizing particle.

Photographic-type films are often used to detect nuclear radiations.

Crystals such as diamonds and zinc sulphide can be made to count in the same manner as G-M tubes and perhaps a suitable crystal will eventually replace the G-M tube detector.

Scintillation counters use a phosphor material in which the incident radiations produce very weak flashes of light which can be detected by a photomultiplier tube.

The instruments are divided into the following two groups:

1 Direct-reading rate meters—instruments which give a direct indication of the radiation intensity. The indicator may be a meter, earphones, a loud speaker, or a flashing neon lamp.

2 Accumulator-type instruments—these instruments indicate the quantity of radiation received during some time interval. External timing devices are used, the time interval for normal use varying from a few seconds to a week or more depending on the function for which the instrument is designed.

Gas-Turbine Power

Interaction of Components of Gas-Turbine Engines for Aircraft, by Arthur W. Goldstein, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1949 ASME Spring Meeting paper No. **49—S-16** (mimeographed).

A method has been developed for conveniently determining the operational states of components of gas-turbine engines, and has been shown to be applicable to the simple jet engine in equilibrium and acceleration, and to gas-turbine engines with jet power, having either a coupled or free-wheeling power-turbine component. Analysis of a jet engine shows that starting is easier with impulse than with reaction turbines.

Analysis of the engine with free-wheeling turbine shows that an increase in jet-nozzle size over the critical size has practically no effect on engine operation except at low engine pressure ratio. Reduction below this size requires higher temperature for constant speed. For critical nozzle size, increase in flight speed also has very little effect on engine operation except at low pressure ratio, where the air flow is increased, thus permitting operation at higher temperatures without surging the compressor.

For an engine with a coupled power turbine, the effect of increase in flight speed on compressor operating state is similar to that for an engine with a free-wheeling power turbine.

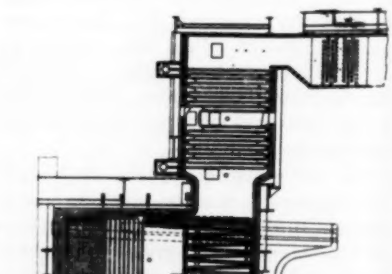
Continental and American Gas-Turbine and Compressor Calculation Methods Compared, by P. F. Martinuzzi, Italian National Research Council, Rome, Italy. 1948 ASME Semi-Annual Meeting paper No. **48—SA-62** (in type; published in Trans. ASME, May, 1949, p. 325).

During a recent tour of the United States, it became evident to the author that there is no standard American method for gas-turbine or for axial-compressor calculations. Apparently each firm goes its own way without much regard for precedents, competitors, or textbooks. In view of the wide diffusion that British data had in this country during the war, it might have been supposed that the Howell method would have been generally used. However, although the actual data given by Howell are considered very reliable, his calculation method is not much used. In practice, calculations seem mostly to be influenced by Keller and, to a much lesser degree, by Traupel. The same situation can be noted as regards gas-turbine-cycle calculations; the paper by Soderberg and Smith is generally well known, but no standard system seems to prevail. To simplify matters, it will be assumed that general American practice can be represented by the methods given in Professor Zucrow's recent book, and in papers by Ponomareff, and Howell, as regards axial compressors.

Mercury Power Plant

Modern Mercury-Unit Power-Plant Design, by D. Douglass, Hartford Electric Light Company, Hartford, Conn., and H. N. Hackett, General Electric Company, Schenectady, N. Y. 1949 ASME Spring Meeting paper No. **49—S-17** (mimeographed).

This paper outlines briefly the general theory of mercury-binary cycle efficiency, how it works, and the more usual types of applications where it may be used. The use of the mercury-steam cycle as applied to topping plants is more completely explained with the relative



CROSS SECTION OF THE 15,000-KW MERCURY BOILER, SHOWING A PORTION OF THE FURNACE TUBES, DOWNFLOW SLAG SCREEN, FOG CONVECTION TUBES, DRUM AND DOWNCOMER-SUPPLY SYSTEM, AS WELL AS THE STEAM SUPERHEATER AND WATER ECONOMIZER

capabilities of 140 psig mercury and 2300 psig steam for such service specifically compared. As a typical as well as the most recent application of a mercury topping unit, the new 15,000-kw mercury-unit power-plant equipment recently installed at the South Meadow Station of the Hartford Electric Light Company, is dealt with in considerable detail. In the manufacture of the mercury-boiler parts, factory prefabrication of relatively large mercury-furnace wall sections was successfully done for the first time. The new 15,000-kw mercury plant has been in operation since Feb. 1, 1949, and for the month of February produced 20,000,000 kwhr of electric power at an average fuel rate of 10,200 Btu per net kwhr.

The efficiency of a vapor cycle is largely determined by the saturated temperature range through which it operates—the greater the range, the higher the efficiency of the cycle.

The mercury cycle, superposed on a steam cycle, boosts the efficiency of the resulting cycle because of the high boiling temperature of the mercury. For example, at 140 psig, mercury boils at 975 F, whereas at 1250 psig, water boils at 575 F.

With 975 F mercury and a proper selection of steam and fuel conditions, thermal efficiencies of from 34 to 38 per cent can be attained.

The mercury-steam-power cycle works as follows:

Heat from the burning fuel is absorbed by liquid mercury within the tubes of the mercury boiler to form mercury vapor, which passes from the boiler to the mercury turbine, where it releases a portion of its energy to produce electric power. The vapor from the turbine is exhausted to the vacuum shell of the mercury condenser boiler. There it condenses and releases its heat of vaporization to water within the tubes. The liquid mercury is returned from the sump, or hot well, to the boiler by a mercury feed pump, or by gravity as the case may be.

The feedwater that absorbs heat from the condensing mercury vapor is boiled into steam at any desired pressure. This steam is then superheated in tubes located in gas passages of the mercury boiler. This superheated steam is then available for driving a steam turbine, or may be put to various other desired uses.

It is of interest to note that the steam thus produced by the binary cycle is only slightly less in amount than it would be if the equivalent fuel were burned directly in a steam boiler.

Marine Fouling

Some Biological Fundamentals of Marine Fouling, by Dr. William F. Clapp, William F. Clapp Laboratories, Inc., Duxbury, Mass. 1949 ASME Spring Meeting paper No. **49—S-15** (mimeographed).

The common mussel is identified as the organism most important in the fouling of sea-water conduits and most difficult to control. Relevant features of its construction, living habits, rates of propagation and growth, and methods of locomotion and self-protection are described.

Chlorination tests on mussels at Kure Beach, N. C., are described and results quoted.

The Kure Beach Station studies were undertaken to determine the comparative value of different schedules of chlorination in control of mussel growth. The procedure was to place a test tray in each of a group of identical weir boxes or compartments supplied with continuously flowing sea water. Turbulence was reduced by a perforated stilling baffle at the mid-length. Water entering the different compartments was chlorinated to selected residual concentrations by automatic feeders on predetermined schedules.

The organism used was the Brachydontes exustus, one of the mussels commonly found in intake systems in southern waters. The normal habitat of this mussel is in the between-tide area, where they grow in such abundance that they frequently completely encrust wharf piling, bulkheads, and other structures in the open sea.

Clusters of the mussels, containing from 50 to 100 specimens of lengths varying from 0.5 mm to 35.0 mm, obtained from between-tide area of a sheet-steel bulkhead were used in the test. Care was taken not to injure the specimens by rupturing the byssus gland in the foot.

Continuous chlorination at 0.25 and 0.5 ppm resulted in a complete kill of Brachydontes exustus. In addition, no fouling organisms of any kind, or slime film, could be found in these weir boxes.

A varying number, probably averaging 50 per cent of Brachydontes exustus were killed in the weir boxes which were provided with intermittent chlorination. In addition, living barnacles and Bryozoa were found in these weir boxes.

ASME Transactions for June, 1949

THE June, 1949, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics*, contains:

Performance of the Viscously Damped Vibration Absorber Applied to Systems Having Frequency-Squared Excitation, by F. M. Sauer and C. F. Garland (49—SA-5)

Thermal Stresses in a Rectangular Plate Clamped Along an Edge, by B. J. Aleck (48—A-28)

Polygonal Approximation Method in the Hodograph Plane, by H. Poritsky (48—APM-23)

The Shape of a Piston Ring in Its Unrestrained State, by C. Chang (48—A-21)

Numerical Solution of Elastoplastic Torsion of a Shaft of Rotational Symmetry, by R. P. Eddy and F. S. Shaw (48—A-20)

Stress Concentration Around a Triaxial Ellipsoidal Cavity, by M. A. Sadowsky and E. Sternberg (48—A-29)

Stability of Linear Oscillating Systems With Constant Time Lag, by H. I. Ansoff (48—A-22)

Dynamic Capacity of Rolling Bearings, by G. Lundberg and A. Palmgren (48—A-19)

Slow-Motion Pictures of Impact Tests by Means of Photoelasticity, by L. Foeppl (48—A-24)

Fracture of Gray-Cast-Iron Tubes Under Biaxial Stresses, by R. C. Grassi and I. Cornet (48—A-15)

A Strain-Energy Expression for Thin Elastic Shells, by H. L. Langhaar (48—A-9)

The Use of the Centrifugal Pendulum Absorber for the Reduction of Linear Vibration, by F. E. Reed (48—A-25)

Supersonic Diffusers for Wind Tunnels, by E. P. Neumann and F. Lustwerk (48—A-14)

Vibration of Slender Bars With Discontinuities in Stiffness, by W. T. Thomson (48—A-17)

Correlation of Tension Creep Tests With Relaxation Tests, by I. Roberts

Note on the Bending of Circular Plates of Variable Thickness, by H. D. Conway (48—A-6)

Stresses and Displacements in a Semi-Infinite Elastic Body With Parabolic Cross Section Acted on by Its Own Weight Only, by R. J. Hank and F. H. Scrivner (48—A-27)

DISCUSSION

On previously published papers by G. A. Nothmann; W. R. Leopold; W. Prager; M. P. White and LeVan Griffis; R. B. Green; J. R. Weske; and J. E. Brock

BOOK REVIEWS

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Who Uses Cube-Root Chart Paper?

To the Editor:

The writer has developed a statistical use for accurately ruled cube-root chart paper to include the scale range between $\sqrt[3]{0.10}$ and $\sqrt[3]{100.00}$, but has been unable to find such paper in the market.

If a manufacturer could be convinced that there is a demand for this type of paper, he might be induced to provide it for general use at an attractive price. Hence the writer would like to hear from readers—engineers, draftsmen, statisticians, mechanics, analysts, and others who would use such paper if it were obtainable.

Raymond M. Brunner.[1]

Circular Saws

Comment by Norman C. Bye[2]

The writer wishes to amplify a point of the author's[3] that circular saws are usually manufactured to standard specifications and as such they can be considered stock items. Few stock tools have to cover as large a field of service requirements as a circular saw. These service requirements cover variations in work resulting from use on hardwoods, softwoods, dry lumber, wet lumber, frozen lumber, cross-grain knots, foreign matter, as well as variations in operation from good conditions on rigid high-powered machines to poor conditions on low-powered poorly maintained machines. Saw standards to meet these service requirements have been based on past experience of performance, and, in many cases, this has resulted in the sacrificing of maximum efficiency of cutting for a particular operation in order to obtain highest-average service benefits.

Owing to the present-day requirements for better operation and lower costs in the users' plants, this situation has changed so that the attainment of maximum cutting efficiency for a particular operation is a major concern. Good fundamental knowledge of the factors involved in cutting wood is not readily available, so that neither the user, the sawmaker, nor the machine builder can readily set up standards for any particular set of conditions. However, we believe the work which is being done to obtain this fundamental information, by the author, by ourselves, and by others interested in the matter is producing results which will enable the sawmaker, the machine builder, and the user to obtain the desired improvement in performance.

In anticipating this improvement there should be a note of caution, because, as any tooling operation improves in efficiency, it usually becomes less universal in its use. Therefore, it is reasonable to assume that for some time to come these improvements in cutting performance will be confined to those applications where properly controlled operating conditions can be obtained. In this connection, proper maintenance of tools and machines cannot be too highly stressed.

[1] Insulation Contractor, 131 Huntington Place, Cincinnati 19, Ohio.

[2] Director of Engineering, Henry Disston & Sons, Inc., Philadelphia, Pa. Mem. ASME.

[3] "Circular Saws—Problems in the Design, Manufacture, and Operation of Standard Saws for All-Purpose Work," by R. D. Brooks, Mechanical Engineering, vol. 71, Feb., 1949, pp. 133–138.

Free Enterprise

Comment by Thomas C. Reeves[4]

The article[5] on the subject of selling free enterprise to employees is an interesting one in that it outlines in some detail a program of semiformal economic education for employees. That such a program would be useful—and even more useful if extended to a limited community basis—this writer does not deny. However, this program, as well as so many others, through its very directness and apparent simplicity tends unintentionally to oversimplify the solution to the problems that beset free enterprise.

There would seem to be two principal problems facing free enterprise. One problem, short range in nature, is the present inflation in our economy. Another more or less long-range problem is the spread of socialist tendencies in our economy, and the subsequent threat to the very existence of free enterprise. These are not unrelated problems by any means. If the first is not solved satisfactorily, the opportunity to solve the second may be withdrawn as a matter of course.

Certainly the solution to inflation and the preservation of free enterprise do not lie along the path of self-interest of any economic group, but in the joint realization that the fortunes of each group, be it industry, labor, agriculture, or any other group, are inseparably bound to the fortunes of the whole. The solution, if one is forthcoming, rests upon whether these groups have reached sufficient moral maturity to recognize and assume their responsibilities for the welfare of the whole. Programs, methods, and techniques are not lacking. Reference books, professional journals, and papers are full of them. The elements which do seem to be lacking are enough men of sufficient moral stature to put these programs, methods, and techniques into effect, regardless of the bitter medicine such application might promise to be.

No one economic group can take it upon itself to speak for any other group. Indeed, the size and variety of interests within each group often make it difficult for a group to formulate even its own policy. But each man within a group can speak for himself, and if every responsible party in industry would "live" free enterprise as fervently as he thinks he believes in it, the problem of its preservation would very likely vanish.

It has been said, and wisely, that labor peace cannot be legislated. It is every bit as true that free enterprise cannot be legislated. Perhaps there has been a move to seek refuge in programs, policies, and codes. Perhaps this has been an attempt to set up an impersonal guide to business relations, so as to camouflage our disinclination or ineptitude to conduct these relations on a basis of personal and moral responsibility.

Programs, policies, and codes, how-

[4] Philadelphia, Pa. Jun. ASME.

[5] "What's the Best Way to Tell Your Free-Enterprise Story to Your People?" by H. R. Nissley, Mechanical Engineering, vol. 71, March, 1949, pp. 222–223.

ever comprehensive and well laid, cannot save free enterprise. Nor can economics courses, slogans, and best-letter contests. The salvation of free enterprise will rest solely on its capacity to convince every member of our economy by performance, and performance alone, that free enterprise offers most, not only in the material sense but in the inner sense of individual freedom and human dignity.

Only the unwitting and the misled can deny that free enterprise has lost considerable ground in recent years. Only the unwitting and the misled can believe that this trend can be reversed or even arrested without immediate, direct, and concerted action.

Even at present, the task of preservation is enormous and demands the sincere participation of every intellectually honest and morally responsible member of management.

This challenge—the moral challenge to practice free enterprise and reject the hypocrisy that threatens to strangle it from within—this is the real challenge to free enterprise.

AUTHOR'S CLOSURE

The author agrees with Mr. Reeves that the antidote to state socialism is something more than rational economics. It is moral courage. It is proving to others that free enterprise is worth saving in America even if it means a temporary loss in profits or "position" by eliminating special-interest lobbies and substituting for them lobbies designed to give the greatest good to the greatest number of people—now and in the long run. There has been an overemphasis upon special "brand" free enterprise by various groups: small businessmen, labor leaders, big businessmen, farmers, independent retailers, and others. As Mr. Reeves points out the salvation of American free enterprise lies in two directions: (1) Knowledge and understanding of economic forces by the entire community, and (2) moral courage on each person's part to do his share in removing free-enterprise obstacles starting with those obstacles that favor him.

HAROLD R. NISSLEY.[6]

[6] Professional Engineer, Cleveland Heights, Ohio.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineerig Societies Library

Sixteenth-Century Mining Literature

BERGWERK—UND PROBIERBÜCHLEIN. A translation from the German of the "Bergbüchlein," a sixteenth-century book on mining geology, by Anneliese G. Sisco, and of the "Probierbüchlein," a sixteenth-century work on assaying, by Anneliese G. Sisco and C. S. Smith with technical annotations and historical notes. The American Institute of Mining and Metallurgical Engineers, New York, N. Y., 1949. Cloth, 5 × 8 in., 196 pp., wood cuts, tables, index, $5 to nonmembers, $3 to members.

REVIEWED BY J. K. FINCH[1]

THROUGH the support of the Seeley W. Mudd Memorial Fund the American Institute of Mining and Metallurgical Engineers has published a most attractive book which offers a thorough and interesting translation, study, and technical appraisal of two "booklets" which constitute the first printed works on mining and metallurgy. Each of these "büchlein" went through numerous editions, thus attesting to their popularity, but there is some doubt as to the date of their first issue. It was probably about 1510 and 1525, respectively.

The first work, of 24 pages, "Bergbüchlein," is described as, "A well-planned, useful little book on how to prospect for and find the ores of the different metals, with illustrations of the lay of the terrain and an appendix of mining terms, which will prove most useful to young miners." The second, a longer publication of some 70 or 80 leaves, "Probierbüchlein," bears the subtitle: "A Little Book on the Assaying of Gold, Silver, Copper, and Lead. Also, How to Assay and Work Profitably All Kinds of Metal. Compiled with great care for the benefit of all mintmasters, goldsmiths, miners, and dealers in metals."

One cannot read these early studies without being deeply impressed by the simply extraordinary, the almost unbelievable, amount of sound "know-how" which man has found it possible to accumulate through pure experience, through pure "try it and see." We are apt, in these days of "scientific" engineering to fail to realize that, for at least forty nine of its fifty centuries of history, engineering was a practical art. Some of the greatest structures man has ever achieved were built in these earlier days of rule of thumb. Similarly in commenting on these early booklets, the translators note that many of the observations, methods, and practices they described are still valid today.

The search for the rationalization of those engineering methods which have been built up through ages of experience and experiment and are being added to even today, goes forward at an increasing tempo, but the engineer still relies on much in the way of know-how which comes from practical life rather than the scientific laboratory.

This is not to say that mistaken ideas and curiously distorted notions do not occur, mixed in with much of real worth, in these two "büchlein." Bits of ancient philosophical speculations of fable, astrology, and pure error are included. The young miner is well advised that he should not spurn the profits which ensue from a study of mineral deposits, but that "if his aim is solely profit and gain rather than the desire to know about the wondrous influences which Nature works under the earth by means of the mineral Power, it would cheapen and condemn this little book." Much of this "mineral power" is attributed to the influence of Heaven, "each metallic ore receives an influence from its own particular planet, specifically assigned to it because of the characteristics of the planet and the ore." Even Agricola of "De Re Metallica" (1558) fame (who it might be noted, copied freely these earlier works) wrote seriously of the queer hobgoblins and other creatures which worked their curious influences in the subterranean depths.

In short, both these volumes represent engineering in its earlier stages of transition from ancient practical arts—which still retained a curious mixture of superstition but carried a remarkable leaven of common sense—to the more realistic com-

[1] Dean, School of Engineering, Columbia University, New York, N. Y.

bination of proved empiricism and science which prevails today.

It is interesting to look back of these two booklets and speculate on the forces and influences which led to their publication. The authors, unfortunately, do not discuss this question.

In part such publications are clearly a response to the spirit of the times in which they were written. In the sixteenth century "natural philosophy" was breaking away from the leading strings of the Church and of Greek philosophy. Modern science was being born. Not until four centuries later was the liaison between natural science and engineering developed. It is also true that the books of this era are empirical works, recipe books, and that they, as we have noted, contain much of earlier philosophical speculation. In addition to reporting "know-how" they pose questions as to origins and "know-why?" which reflect the awakening of the free spirit of modern inquiry and the scientific mind.

The later years of the Renaissance witnessed the publication of a number of classical works in mining and metallurgy, culminating in Agricola's famous work which, as ex-President Hoover recalls, remained practically the standard text in this area for some 180 years. Why?

Various explanations have been suggested. The booklets before us deal particularly with the precious metals. Gold and silver were pouring into Spain from her conquests in the New World. The outside nations had to do something about this situation if they were to maintain their essential trading positions in the world of that day. The ancient mining deposits, especially in Saxony, were given new importance and this South German development marked, in large measure, the birth of modern mining. These early publications were almost all of German origin.

In the baser metals also an earlier chemical discovery, the atom bomb of medieval times, gunpowder, played an important part. The casting of cannon became a most stimulating factor in the rise of the metallurgy of brass and iron. It might also be noted that problems of range and trajectory accounted for a small flood of sixteenth-century books on surveying which were devoted almost entirely to military problems.

These "büchlein" are thus interesting, not only as pioneer mining and metallurgical works but in reflecting the state of engineering progress and the economic relationships of our profession four-hundred or more years ago when Modern Engineering was emerging from the ashes of Ancient Engineering.

Frank and Lillian Gilbreth

FRANK AND LILLIAN GILBRETH: PARTNERS FOR LIFE. By Edna Yost. Foreword by A. A. Potter. Rutgers University Press, New Brunswick, N. J., 1949. Cloth, 5¼ × 8 in., xii and 372 pp., plates, $5. By arrangement with the publisher the ASME is issuing a Special Subscription edition which will be available to members of ASME at $4.40; to nonmembers $5.50.

REVIEWED BY J. M. JURAN[2]

THE wholesome reception accorded to the current best seller "Cheaper by the Dozen"[3] is by no means due solely to the many hilarious incidents which took place in the lives of the Gilbreth family. Behind the gay flicker of those incidents is the steady warmth of enduring family unity. The insight thus provided into a family harmony achieved by working together in friendly co-operation has left with many readers an impressive lesson in human relations.

It is most timely, in this setting, for Edna Yost to have completed her work on the lives of Frank and Lillian Gilbreth. To The American Society of Mechanical Engineers this book has special significance as a biography of two of its distinguished members. This special significance has been recognized by authorizing a special edition of the work bearing the imprint of the Society.

It was no ordinary biographical problem which confronted Miss Yost. Many of the events and incidents are of course compounded of the humble stuff which abounds in human history. But much was not usual with the Gilbreths. The techniques of motion study and the ramifications are not so simple to record. Even more elusive are the vast implications of the work in Motion Study as a means for removing much toil and drudgery from the backs of the human race. Still more elusive is the work in Psychology of Management with its promise of greater harmony within the Industrial Society.

To her great credit, Miss Yost has captured and portrayed these difficult concepts and implications. Yet she has the while kept a sense of proportion of things. In her book, all of these achievements are properly subordinate to the main story—the story of a Partnership profound beyond understanding.

To the engineer, the story of Frank Gilbreth, the bricklayer who became a leading builder of his day, would of itself be of great interest. Here was a man who found new ways in old, old surroundings. His inventions of concrete mixers and adjustable scaffolds, his early appreciation of the problems of the workman, his keen concern for ethical relations with the public—these and other activities stamp him as a man whose purpose was to put as much into life as he could, not to get out what he could. For example, he paid, in 1908, the amazing wages of $6.50 per day to bricklayers. Yet in turn, through his methods and through the teamwork spirit, these bricklayers achieved amazing production records.

But it was the Partnership which so greatly multiplied the productivity of each of the partners. It was the Partnership which wrought the Science of Motion Study, which found truths of human relations hidden behind the shrubbery of conventional thinking and it was the Partnership which brought forth and reared the family whose tender and hilarious story has so skilfully been related by two of the children.

Miss Yost's task has been so difficult that we may well forgive her impatience with the engineering profession for having waited so long to grasp fully the work of the Gilbreths. Manifestly, the more visionary a concept the greater is the corresponding time interval required for public recognition. If the time interval is not great, the concept was very likely not visionary.

Following the untimely death of Frank Gilbreth in 1924, the spirit of the Partnership carried on. The eleven children all completed college educations. The work in motion study and in psychology continued, in dynamic force. If anyone thinks it has become static, let him listen to any address by Lillian Gilbreth. As this review is written, this reviewer's ears are still ringing with the youthfulness of Lillian Gilbreth's address at the Western Hemisphere Conference on Management (Quebec, May 13–14, 1949). Her emphasis, as always, was on the new developments, and she spoke, as always, with a twinkling eye—"Cybernetics—I don't know how to spell it, I don't even know how to pronounce it, but I do know. . . . ."

The work of the Gilbreths has now permeated much of industry, the farm, the home, indeed all of human activity. Recognition, long delayed, has now been forthcoming. Year after year, new

[2] Professor and Chairman, Department of Administrative Engineering, New York University, New York, N. Y. Mem. ASME and Chairman, Publications Committee.

[3] "Cheaper by the Dozen." By Frank B. Gilbreth, Jr., and Ernestine Gilbreth Carey. Reviewed in MECHANICAL ENGINEERING, vol. 71, no. 4, April, 1949, page 351.

honors are bestowed on the Gilbreths. Yet the First Lady of Engineering regularly attends committee meetings, regularly participates in program making, regularly continues to exemplify how one can remain devoted to the common good.

Those of us who are privileged to work today with so modest a person as Lillian Gilbreth find it hard to realize that we are walking hand in hand with a person so greatly symbolic of human progress. All engineers owe a debt of gratitude to Miss Yost for having prepared, in such admirable perspective, this inspiring story. Not only engineers, but all who aspire to eminence in a profession can derive the highest inspiration from a study of the partnership of the Gilbreths.

Handbook of Patents

HANDBOOK OF PATENTS. By Harry Aubrey Toulmin, Jr. D. Van Nostrand Company, Inc. New York, N. Y., Toronto, Can., and London, England, 1949. Cloth, $5^3/_4 \times 9$ in., viii and 800 pp., figs., plate, $9.

REVIEWED BY EDWARD GOTTLIEB[4]

THIS reviewer has one point of criticism and many points of praise for this book. In praise I would say the book is more than merely a "handbook" since it is readable from cover to cover for leisure enjoyment. Of course the subject is fascinating, easily capable of holding the reader's interest.

In one way the book is aptly entitled handbook because of its generous index. The chapters are arranged to systematically develop the entire subject, and each chapter is subdivided into sections covering specific points. It is possible to consult the index and quickly find sections which answer practically any question relating to patents.

The entire field of patents is covered. Starting with the reasons for our patent system and the economic background of invention and research, the author progresses to patent fundamentals—how to draft a patent application and prosecute it in the Patent Office, how to keep patent records, how to investigate patent records to protect patent rights, patent litigation, foreign patents in the United States, international conventions and agreements, contracts, patents in income-tax returns, etc.

Of course it is folly to assume that after reading the book one will be an expert in patent matters, able to prepare and prosecute patent applications, handle one's own contracts, etc. Then what is the value of the book to an inventor, executive, or engineer? Its value lies in the fact that the reader will be an intelligent client, patent-wise, of his patent attorney. A patent attorney cannot properly protect most inventions unless he has the intelligent co-operation of his client. In many instances it is necessary to "guess" what a future infringer may conceive to avoid infringment. An informed client knows just what angles can probably be explored to avoid future disappointments. An uninformed client is anxious to obtain broader protection than is possible, and talks in broad terms, and usually important specific points are overlooked. Often during the prosecution of a case the Patent Office examiner starts a discussion on combination, aggregation, and double patenting. An attorney, wishing to discuss the action with his client, becomes discouraged unless the client has some knowledge of the subject. In a case of this nature the "Handbook of Patents" is immensely valuable to the client. In fact, the book will also be of great value to the patent attorney as a reference book.

The only criticism of the book relates to its appendix which gives the old Rules of Practice in the U. S. Patent Office. The book is newly published, copyrighted 1949. The new Patent Office rules became effective March 1, 1949. It would have been better to have delayed publication for a short time in order to give the new rules, as the old rules are now completely obsolete. Fortunately, however, copies of the new rules may be obtained gratis by writing to The Commissioner of Patents, Washington 25, D. C.

[4] Patent Attorney, New York, N. Y. Mem. ASME.

Foundations for Constructive Industrial Relations

FOUNDATIONS FOR CONSTRUCTIVE INDUSTRIAL RELATIONS. By R. Carter Nyman. Funk and Wagnalls Co., New York, N. Y., in association with *Modern Industry Magazine*, New York, N. Y., 1949. Cloth, $5^1/_4 \times 8$ in., xiv and 209 pp., 11 figs., $2.85.

REVIEWED BY DONALD C. WILSON[5]

THE author establishes as his goal the setting forth of suggestions of tentative and hypothetical concepts and principles which underlie what he chooses to term a scientific approach to the administration of industrial relations.

In the first chapter Mr. Nyman outlines the purpose of the book which is to treat the implications of psychological knowledge concerning the attributes and processes of human nature; he goes into an evaluation of the nature and effects of environmental and social conditioning. Then there follows an outline of the basic conditions required for sound human relations. Following this, a very interesting and successful attempt is made to develop principles of administration having validity in terms of these fundamentals. The implication carried by these principles as they affect the interrelations between capital, labor, and government is then discussed. The concluding chapters are used to discuss an analysis of the nature and proper use of the power of management.

The concept developed and discussed deals with industrial relations in a broad sense but the basic point made is the real need for treating of management problems in a scientific or professional manner. Repeatedly the need for integration in the various functions of management is emphasized. The recognition of the existence of industrial relations as a function touching capital, labor, and government, as well as the social, economic, and political phases of our life, is used as one of the basic reasons for emphasizing the virtual necessity for the treatment of industrial relations in a scientific yet human manner.

The joint management-labor-government approach to industrial relations is suggested as being highly desirable in that it affords an opportunity for labor to develop a sense of belonging and understanding. In this connection repeated reference is made to the necessity for managers to avoid creating situations which would result in any individual falling into a subservient status. As the author effectively points out, subordinate status must be created and maintained but no subordinate should be subservient. The desirability for such thinking is based on the generally accepted premise that all human beings like to have a status of independence and self-respect in their relationships. The author feels this desire can be satisfied, providing an individual understands he is a subordinate but cannot be attained if he is treated in any way as being subservient.

Generally speaking, this book is based on sound "technical science" concepts and for this reason contributes a great

[5] Personnel Manager, York Corporation, York, Pa.

deal to furthering sound industrial relations; however, occasionally the author departs from the objective treatment of his subject and gives way to statements which hardly do justice to the book as a whole.

Specific industrial-relations problems are not treated per se inasmuch as it is not the purpose of the book to do so. The approach used to the subject is sufficiently sound and so developed that the result is a stimulating and thought-provoking work. This is a good book for managers to read.

Books Received in Library

AIRCRAFT ELECTRICAL SYSTEMS, HYDRAULIC SYSTEMS, AND INSTRUMENTS. By R. H. Drake. The Macmillan Company, New York, N. Y., 1949. Cloth, 6 × 9$^1/_2$ in., 393 pp., illus., diagrams, \$5.60. Written in nontechnical language, this book is intended for use as a classroom text, reference, or guide for self-instruction. It is divided into three sections. Part 1 covers the fundamentals of electricity and aircraft electrical systems; Part 2, the fundamentals of hydraulics and aircraft hydraulic systems; and Part 3, the principles underlying the construction and operation of aircraft and engine instruments.

BIBLIOGRAPHY OF RUBBER LITERATURE FOR 1942 AND 1943 (including Patents). American Chemical Society, Division of Rubber Chemistry, 1948. Cloth, 6$^1/_4$ × 9$^1/_4$ in., 351 pp., free to members of American Chemical Society, Rubber Division; available to nonmembers, \$5. *Rubber Age*, New York, N. Y. Continuing the work started by *Rubber Age* in 1936, the present compilation lists articles from nearly 400 scientific and technical journals from all over the world. The same as in the preceding edition, the current one includes patent as well as literature references, there being some 3850 items in all. The main listing is under 72 alphabetical classifications, with author index and a detailed subject index. All references to the same article (original, translation, abstract, etc.) are grouped as a single item for the convenience of the user.

BIBLIOGRAPHY ON X-RAY STRESS ANALYSIS with Subject Index. By H. R. Isenburger. St. John X-Ray Laboratory, Califon, New Jersey, 1949. Stiff paper, 8$^3/_4$ × 11$^1/_2$ in., 17 pp., diagrams, \$3. Covering the period from 1925 to 1948, this bibliography contains 240 references covering methods, results, and interpretations, in chronological order. A subject index has been added to facilitate the use of the bibliography.

FIVE-FIGURE TABLES OF MATHEMATICAL FUNCTIONS. By J. B. Dale. Edward Arnold & Co., London, England; Longmans, Green and Co., New York, N. Y.; second edition, 1949. Cloth, 5$^1/_2$ × 8$^3/_4$ in., 121 pp., tables, \$1.50. This small book provides tables of logarithms, powers of numbers, trigonometric, elliptic, and other transcendental functions. Decimal equivalents, conversion of time and angular measure, and a compilation of special numbers used in calculations are included. The five-figure entry has been used as the most effective for all-round practical use.

FRACTURE OF MILD STEEL PLATE. (Admiralty Ship Welding Committee Report No. R.3.) By C. F. Elam Tipper. His Majesty's Stationery Office, London, England, 1948. Paper, 8$^1/_2$ × 11 in., 41 pp., illus., diagrams, charts, tables, 6s 6d. This report is based on research carried out at the Engineering Laboratory, Cambridge. It is divided into the following sections: descriptions of fractures in actual ship plate; experiments designed to reproduce similar fractures in the laboratory; development and study of a notch test; metallurgical investigation of the plates; the effect of notches on ductility and fracture; discussion of the results; and tables. Over 80 references are cited, and 90 diagrams and illustrations are included.

GRAIN CONTROL IN INDUSTRIAL METALLURGY. By J. E. Burke, R. L. Kenyon, H. Burghoff, J. T. Hobbs. American Society for Metals, Cleveland, Ohio, 1949. Cloth, 6 × 9$^1/_4$ in., 279 pp., illus., diagrams, charts, tables, \$5. Four lectures presented at the 1948 National Metal Congress are included, as follows: fundamentals of recrystallization and grain growth; recrystallization and grain control in ferrous metals; recrystallization and grain control in copper and copper alloys; grain control in wrought aluminum and magnesium products. A glossary of terms used is provided.

PUMP HANDBOOK. By V. C. Finch. National Press, Millbrae, California, 1948. Cloth, 5$^1/_2$ × 8$^3/_4$ in., 202 pp., illus., diagrams, charts, tables, \$4. This book is designed to make it easy for anyone concerned with pumps to acquire sufficient knowledge to enable him to select the right pump, to know when a pump is properly installed, and to keep it operating successfully and economically. Centrifugal, rotary, and reciprocating pumps are considered, as well as boiler feed, propeller, mixed-flow, peripheral, and deep-well turbine pumps among other specialized adaptations.

SCIENCE AND ENGINEERING OF NUCLEAR POWER, Volume 2. By A. O. Allen and others. Edited by C. Goodman. Addison-Wesley Press, Cambridge, Mass., 1949. Cloth, 8 × 10$^3/_4$ in., 317 pp. plus index; illus., diagrams, charts, tables, \$7.50. Of value to those interested in the industrial applications of nuclear energy, this volume contains 17 pages on specific aspects of the subject. Source materials, isotope separation, various aspects of pile design, applications to rockets, effects of radiation, health physics, and future developments of nuclear energy are discussed. The previous volume contained 12 papers constituting a general survey of the fundamentals of chain-reacting systems.

SEALING MECHANISM OF FLEXIBLE PACKINGS. Great Britain, Ministry of Supply, Scientific and Technical Memorandum No. 3/47. By C. M. White and D. F. Denny. Published by His Majesty's Stationery Office, London, England, 1948. Paper, 7$^1/_2$ × 9$^3/_4$ in., 112 pp., plates 1–16, illus., diagrams, charts, tables, paper, 10s 6d. This report describes experiments which show how pressure is distributed over the surface of flexible packings, and how they deform under pressure. Rectangular section, toroidal, and U-section packing were studied. The various ways in which failure may take place are considered, and arrangements for reducing failure are discussed. Results of experiments measuring frictional effects are included.

TABLES OF BESSEL FUNCTIONS OF FRACTIONAL ORDER, Volume 2, prepared by the Computation Laboratory of the National Applied Mathematics Laboratories, National Bureau of Standards. Columbia University Press, New York, N. Y., 1949. Cloth, 8 × 10$^3/_4$ in., 365 pp., tables, \$10. The present volume, devoted to the tabulation of $I_\nu(x)$ for $\pm\nu = {}^1/_4, {}^1/_3, {}^2/_3, {}^3/_4$, is a sequel to the volume containing $J_\nu(x)$ for the same orders. The functional values in both volumes are given either to ten decimal places or to ten significant figures. The tables cover a range of x from 0 to 25. Tables for facilitating interpolation and a list of constants are included.

TABLES OF THE BESSEL FUNCTIONS OF THE FIRST KIND OF ORDERS FORTY THROUGH FIFTY-ONE. (Annals of the Computation Laboratory of Harvard University, Volume 11.) By the Staff of the Computation Laboratory. Harvard University Press, Cambridge, Mass., 1948. Cloth, 7$^3/_4$ × 10$^3/_4$ in., 620 pp., tables, \$10. Continuing the series of tables computed by the automatic-sequence-controlled calculator, the present volume extends the coverage of Bessel functions of the first kind. Computational techniques and the calculator itself are described in earlier volumes of the series. As before, the tables are carried to ten decimal places.

TABLES OF THE CONFLUENT HYPERGEOMETRIC FUNCTION $F\left(\frac{n}{2}, \frac{1}{2}; x\right)$ AND RELATED FUNCTIONS. (National Bureau of Standards, Applied Mathematics Series 3.) United States Government Printing Office, Washington, D. C., 1949. Paper, 8 × 10$^1/_4$ in., 73 pp., diagrams, tables, \$0.35. These tables, of importance in connection with the so-called analysis-of-variance tests, are also intended to facilitate the construction of other tables needed for sequential analysis and various other statistical tests. The tables are carried out to six decimal places. The analytical properties of the function are discussed and a group of interpolation charts are included with explanation.

TEXTBOOK OF WOOD TECHNOLOGY, volume 1. By H. P. Brown, A. J. Panshin, and C. C. Forsaith. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1949. Cloth, 6 × 9$^1/_4$ in., 652 pp., illus., diagrams, tables, \$6. This book is based on "Identification of the Commercial Timbers of the United States" by Professors Brown and Panshin. It offers factual information on the structure, identification, general properties, uses, and major defects of commercial wood in the United States. The International Code of Nomenclature is used. A new master key for the identification of coniferous woods has been added, and the glossary of technical terms enlarged. The projected second volume will cover the physical, mechanical, and chemical properties of wood.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, ASME, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the Cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is submitted to the Board on Codes and Standards, as authorized by the Council of The American Society of Mechanical Engineers, for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of April 8, 1949, and approved by the Board on Codes and Standards under the date of May 24, 1949.

CASE No. 897 (*Reopened*)

Inquiry: May chrome-nickel austenitic steels as such, or alloyed with columbium, titanium, or molybdenum, be used in the construction of unfired pressure vessels under ASME Code rules?

Reply: Chrome-nickel austenitic steels as such, or alloyed with columbium, titanium, or molybdenum, may be used in the construction of unfired pressure vessels without consideration of their corrosion or heat resistant properties (note appendix for recommendations), provided the rules of design, fabrication, and inspection of the Code are followed except as follows. It shall be the responsibility of the user to determine whether or not degree of corrosion in intended service warrants specifying vessel, shall be built for corrosive service.

(1) *Specifications*

(*a*) The alloy chrome-nickel material may be any Austenitic Grade of such material made to any approved SA specification that is included in Section II or to Specification A-167 provided the mechanical properties specified in Table II of that specification are met. Other physical forms made to the same specifications as far as possible may be used provided in particular that the mechanical strength requirements of the specification be met.

The addition of columbium to the M grade of Specification SA-240 is permitted. The amount shall not exceed that specified in Specification SA-240 for the C grade. For optimum resistance to formation of sigma phase (brittle) material a more restricted analysis than permitted by Specification SA-240 has been found advisable, as follows:

Carbon........	0.07 max %
Chromium....	17.50–19.00%
Nickel........	13.00–15.00%
Molybdenum..	2.00–2.50% (2.25 preferred)
Columbium...	9 times carbon content; 0.9 max %
Manganese....	1.50 min %
Silicon........	0.75 max %
Sulphur.......	0.03 max %
Phosphorus...	0.03 max %

This grade of material shall be marked "Mc" for identification.

(*b*) When used in vessels specified by the user to be for corrosive service, the alloy chrome-nickel material shall conform to the requirements of Appendix A(1)(*b*).

(*c*) *Marking.* In addition to the marking required by the specification, the heat treatment if carried out by the manufacturer or supplier of the material shall be marked (3)(*a*), (3)(*b*), or (3)(*c*) to indicate the type of heat-treatment given in the manner called for in specification.

(2) *Impact Testing*

Impact tests as provided in Par. U-142 shall be met by material for any one of the following:

(*a*) When any of the authorized materials are used below —300 F; (*b*) when materials having either a carbon content over 0.08 per cent, or a higher nickel or chromium content than the A.I.S.I. standard analysis range for the type and physical forms of materials specified or when material of 0.08 maximum carbon content, and otherwise of approved specification composition, containing columbium or titanium is given heat-treatment (3)(*c*); or when lacking it, is given heat-treatment (3)(*b*) or (3)(*c*); are used below —20 F; (*c*) when Grade Mc material that is not within the analysis range recommended in (1)(*b*) is given heat-treatment (3)(*b*); or (*d*) when Grade M or Type 309 material is given heat-treatment (3)(*c*) at temperatures under 1650 F. Impact tests shall be made of any castings and of weld metal as provided in Par. U-142 for all welded vessels intended for use below —20 F.

(3) *Heat-Treatment*

Heat-treatment of the completely welded vessel by one of the following procedures, (*a*), (*b*), or (*c*), is mandatory for all vessels built in accordance with Par. U-68 or Par. U-200 construction and for all vessels built in accordance with Par. U-69 or Par. U-201 construction when the thickness requires stresss relief under Par. U-76. (The stress relieving requirements of Par. U-76 are superceded by the heat-treatment requirements of this paragraph.) For vessels not to be heat-treated after welding, the material shall be heat-treated by the appropriate procedure either (*a*) or (*b*) as the last heating operation before welding.

(*a*) Heat the material or the vessel to 1900 F to 2000 F for Grades S, C, and Types 309 or 310; to 1850 F to 1950 F for 309 Cb, Grade T and Grade Mc of Spec. SA-240, and to 1950 F to 2050 F for Grade M of Spec. SA-240; and to the same temperatures for the corresponding grades of other specifications or to 1850 F minimum. Hold at this temperature for one hour per inch of maximum thickness, but in no case less than one-half hour. Quench all parts of the material or vessel uniformly and as rapidly as possible. For all Grades that do not have columbium or titanium specified, the time consumed in cooling from 1700 F to 1000 F shall not be more than three minutes. The rapid cooling shall be continued below this temperature. (See Appendix (2) of this Case for cautionary note on stress corrosion cracking.)

(*b*) Heat the material or the vessel to 1550 F minimum for Grades C and Mc or Type 309 Cb, and to 1550 F to 1650 F for Grade T. This treatment is applicable only to grades in which columbium or titanium are specified. Hold at these temperatures for two hours per inch of maximum thickness but in no case for less than two hours. Cool in still air or in the furnace.

(*c*) Heat the material or the vessel to at least 1300 F in accordance with the rules of Par. U-76 of the Code except that the rate of cooling may be increased. This treatment may be applied to material or vessels of any of the authorized grades except Grade Mc or Type 309 Cb. When heat-treatment below 1550 F is used for vessels made of Grades C and T material, or heat-treatment below 1900 F is used for vessels made of grades in which columbium or titanium are not specified, a free bend test specimen of the same materials as in the shell of the vessel, and welded by the same procedure, shall be made, heat-treated using the same temperature cycle as used for the vessel and tested. The test results shall meet the requirements of Q-109 (b), Section IX of the Code for the class of construction involved. Reheat-treatment of the vessel and another specimen at a higher temperature is permitted as often as may be necessary to pass the test. (See Appendix A2 for cautionary notes.)

(4) *Thickness Limitations*

The Code limitations on thickness shall apply except that the minimum thickness permitted is $^{1}/_{16}$ in. for noncorrosive conditions of service and $^{3}/_{32}$ in. for corrosive conditions of service. (See Appendix for cautionary note about heat-treating thick sections.)

(5) *Temperature Limitations*

The Code limitations on service temperature shall apply to the various types of construction. (See Appendix A-2(*b*) for cautionary note about use at sensitizing temperatures.)

(6) *Allowable Working Stresses*

For Par. U-68 and Par. U-69 vessels the maximum allowable working stresses shall be those given in Table U-2 and when the operating temperature is below −20 F the allowable working stress shall be that given in the table for −20 F to 650 F. For Par. U-200 and Par. U-201 vessels the maximum allowable working stresses shall be 1.25 times those for Par. U-68 vessels at the same temperature. For Par. U-70 vessels the maximum allowable working stresses shall be 1.25 times the maximum allowable stresses given in Par. U-70(**a**) and (**b**) for carbon steel materials.

The maximum allowable working stresses for Grade Mc material shall be the same as permitted for Grade M material by the rules above for any temperature up to and including 1000 F maximum.

(7) *Fabrication and Testing*

(*a*) Fabrication shall be done and weld tests made in accordance with the requirements of the Code, including qualification of the welding procedure used and of the welding operators employed to meet the requirements of Section IX except as hereinafter provided:

When material having a carbon content of 0.15 per cent and over is to be used the welding procedure qualification tests shall be made using material having a carbon content within 0.02 per cent of the maximum used in construction. Heat-treatment of test specimens is not required but if used shall duplicate the treatment intended for the finished vessel.

The deposited weld metal shall have a carbon content not over that specified for the parts joined and have other elements within the AISI limits of composition for the grade of material used in the parts joined, except that when the fabricator is of the opinion that a physically better joint can be made by departure from these limitations and the user and the inspector are satisfied that the corrosion resistance will be sufficient for the intended service, these limitations may be waived. When columbium is used in the weld metal it shall not exceed 1.00 per cent and when titanium is used it shall not exceed 0.6 per cent. Columbium may be substituted for titanium in weld metal containing 3 Grade material.

(1) In the welding procedure qualification for butt welds in material less than $^3/_{32}$ in. in thickness, all tests called for in Table Q-1 may be omitted except the two reduced-section transverse tensile test specimens and two free bend test specimens which shall be made of the thinnest material to be used in construction, and in accordance with Figs. Q-6 and Q-7. These specimens when tested in accordance with Par. Q-108(**a**) and (**b**) shall meet the test requirements of Pars. Q-109(**a**) and (**b**).

For qualification of a fillet welding procedure in such material, all tests called for in Par. Q-105(**b**) may be omitted except the two transverse shear test specimens which shall be made of the thinnest material to be used in construction, and in accordance with Fig. Q-4. These specimens when tested in accordance with Par. Q-108(**d**) shall meet the test requirements of Par. Q-109(**d**).

(2) The operator qualification tests for welding materials less than $^3/_{32}$ in. in thickness shall be the same as for $^3/_8$ in. thick material except that the thickness used for the test welds shall be the thinnest material to be used in construction. These specimens when tested in accordance with Par. Q-208 in a guided bend test jig modified as called for in (3) shall meet the test requirements of Par. Q-209. This test shall qualify the operator for welding a range of thickness from the test thickness to twice the test thickness, inclusive.

(3) If the thickness of the guided bend test specimen is other than $^3/_8$ inch, the testing shall be done in a test jig similar to Fig. Q-19 with the plunger and die member proportioned as follows:

Thickness of plunger member	= 4 times the thickness of the test specimen
Radius of plunger member	= 2 times the thickness of the test specimen
Width of opening die member	= 6 times the thickness of the test specimen plus $^1/_8$ in.
Radius of die member	= 3 times the thickness of the test specimen plus $^1/_{16}$ in.

Appendix to Case No. 897

A(1*a*) It is expected that vessels of alloy steels covered by these rules will often be used to hold liquids and gases corrosive to ordinary materials, but the selection of an alloy suitable for the vessels' contents and the determination of corrosive allowance are not covered by these rules.

It is recommended that users assure themselves by appropriate tests, or otherwise, that the alloy selected and the treatment following fabrication are suitable for the service intended.

Where service data are not available, the procedure of Par. U-11(**b**) should be followed.

(1*b*) When used in vessels specified to be for corrosive service, the alloy chrome-nickel material shall conform to Specification SA-240, Grades S, M, C, T, or Types 309, 309 Cb, and 310 for sheets and plates; to Specification SA-213, austenitic grades TP304, TP321, TP347, TP316 for seamless tubes; to Specification SA-249, Grades TP304, TP321, TP347, TP316, TP317 for welded tubes except that the specified maximum carbon content of 0.08 per cent may be increased to a maximum of 0.10 per cent for any of these Grades in accordance with the recommendations of the Appendix to this case, depending upon how much corrosion resistance is believed by the user to be needed for the intended service. Other physical forms made to the same specifications, as far as applicable, may be used. The chemical requirements of Specification SA-240 may be substituted for the chemical requirements either in Specification SA-213 or in SA-249.

(A2) The following recommendations are made as a guide in selection of the quality of material, its fabrication and heat-treatment likely to be found to give satisfactory service. The material is useful for many severely corrosive conditions of liquid and vapor exposure, for mildly corrosive conditions, or for avoiding contamination of the vessel contents with iron as well as for strength at elevated temperatures. In consequence of this versatility of the material, these recommendations cannot be more than indicative. Furthermore, these recommendations are based to a considerable extent on practical experience with material produced with less exacting chemical composition and physical control methods than are now available.

(*a*) The use of material having 0.08 per cent carbon or less is recommended with heat-treatment 3(*a*) when it is advisable to have the highest possible corrosion resistance for most conditions of exposure, but heat-treatment 3(*b*) has been found to be preferable under some conditions which usually include exposure to chlorides. Austenitic chrome-nickel stainless steels, when in a condition of internal stress and exposed to certain aqueous chloride solutions, may fail by stress corrosion cracking. Consideration should be given to stress corrosion cracking in this and other corrosive environments to which the vessel may be exposed, in cases where the vessels are quenched as provided in (3)(*a*). Some users drastically reduce the design stresses to escape this danger.

(*b*) The use of material having up to 0.10 per cent carbon with heat-treatment (3*a*) or (3*b*) is usually satisfactory for conditions of service where the object of the use is to prevent contamination of the product with iron and is often satisfactory for uses in which the corrosive conditions are mild. The same danger of stress corrosion cracking exists as for the lower carbon content material when quenched as provided in (3*a*). It should be recognized that the use of 0.10 per cent carbon and higher in material of the Grades in which columbium or titanium are not specified increases the danger of intergranular corrosion and in such cases frequent service inspections may be necessary to assure safety of the vessels.

(*c*) The use of vessels of any of the materials covered by this case which have not been heat-treated subsequent to fabrication may give satisfactory operation from the corrosion viewpoint. Usually the time to cool from welding heat to below the "sensitizing" temperature is an important consideration, hence thin materials are more likely to operate satisfactorily than thick. The reduction of corrosion resistance in the weld zone should be recognized.

(*d*) The use of material having above 0.15 carbon content for any welded pressure vessel involves too much risk of welds of deficient ductility through carbide precipitation to justify use under Code rules without special care in welding procedure, although the corrosion resistance may be sufficient for the service needs.

(*e*) The use of heat-treatment (3)(*c*) is intended primarily for stress relief after welding.

(*f*) The use of very heavy sections when employing the heating and quenching treatment of (3)(*a*) involves the danger of stress corrosion cracking, but such trouble has not been experienced in any of a few scattered installations up to $2^1/_2$ in. thickness.

(*g*) The use of heavy sections under conditions of repeated thermal shock is not recommended.

(*h*) Use in the sensitizing temperature range between about 800 F and about 1500 F, which range varies irregularly with composition, causes appreciable deterioration in corrosion resistance. Rapid destruction of a vessel after prolonged exposure to temperatures in this range followed by exposure to corrosive conditions would be expected unless counteracting measures be taken. Some physical strength deterioration varying with the environment is to be expected as well. The loss of impact strength (notch toughness) is usually appreciable in all grades but greatest in the M Grade after prolonged exposure to high temperature corrosion. Proper "balancing" of ferrite and austenite-forming elements in the composition to maintain a fully austenitic condition tends to prevent such loss of strength. Because the deterioration in strength is to a considerable extent due to grain boundary changes, superficial surface examination and hydrostatic retesting may not reveal the extent of the damage. Microscopic examination and bend tests of samples from the stressed walls are recommended to provide assurance of continued safety in use.

A(3)(*a*) When the vessel is specified by the user to be for corrosive service, the following additional requirements shall be met unless the user, by agreement with the fabricator and inspector, substitutes other requirements:

(1) The material shall have been heat-treated as the last heating operation previous to fabrication by heat-treatment 3(*a*) or 3(*b*) or the completed vessel shall be heat-treated by one of these two procedures when the material is more than $^1/_2$ in. thick. Heat-treatment 3(*c*) shall not be used.

(2) The welded test plates for Par. U-68 vessels shall include an additional free-bend specimen, and for other vessels that require heat-treatment after fabrication there shall be provided a similar welded free bend specimen. Seamless forged vessels shall be provided with a prolongation on one end from which to prepare a similar free-bend specimen. These additional free bend specimens are for testing under Par. (5) below.

(3) The welded test plates shall be made from material from one of the heats of material used in the main shell of the vessel and shall be welded by the same procedure as used in the longitudinal joints of the vessel.

(4) The test plates shall be heat-treated using the same temperature cycle as used for the vessel. The treatment given the test plates shall duplicate, as closely as possible, the physical conditions of the material in the vessel itself.

(5) The free-bend test specimen shall be ground and polished. Immerse in a boiling copper-sulphate sulphuric-acid solution for a minimum of 72 hr. This solution shall consist of 47 cc concentrated sulphuric acid and 13 g. of crystalline copper sulphate ($CuSO_4$.-$5H_2O$) per liter of water. The sample shall then be bent so as to confine the bend to a point $^1/_4$ in. from the edge of the weld in base metal, and the least elongation in the outer fibers measured across the weld shall be not less than 20 per cent. After bending, they show no sign of disintegration.

CASE No. 1022 (*Reopened*)

Inquiry: Par. Q-205 of the Code requires welding-operator tests for groove welds to be made in materials $^3/_8$ in. thick and that when using pipe or tubing, the nominal diameter shall be not less than 6 in. Is it mandatory that these values be adhered to in all Cases?

Reply: The tests described in Par. II of the Welding Qualification Section of the Code are intended for universal qualification of a welding operator and the diameter and the thicknesses designated were chosen for that purpose.

CASE No. 1092

Inquiry: Par. U-13(**b**) of the Code provides for the general use of cast iron for pressure vessels, but limits the use of cast iron under Specification SA-48 to grades no higher than Class 40. As this specification was adopted from ASTM Specification A 48-41, and the presently acceptable revision under ASTM is A 48-46, which provides also for the use of Classes 50 and 60 without a requirement on heat-treatment for stress-relief, may large cylindrical pressure vessels to be used as paper or felt drier-rolls be constructed of these higher strength cast irons designed on working stresses proportionately higher than as shown in the Table of Values of Par. U-13 (**b**)(3)?

Reply: It is the opinion of the Committee that large cylindrical pressure vessels to be used for paper or felt drier-rolls of cast iron may be constructed of material specified in ASTM A 48-46 for Classes 50 and 60 on working stresses as follows:

Class	Maximum tension	Maximum bending	Maximum compression
50	5,000	7,500	10,000
60	6,000	9,000	12,000

The design and construction shall conform in all other respects to the rules given in the Code including those in the Material Specification SA-48 and provided:

(1) The design gives due consideration to the degree of secondary stress imposed on the shell by dynamic and static external loading when added to the hoop stress computed for the internal pressure

(2) Each casting has an approximately uniform distribution of metal around the circumference

(3) Each casting is allowed to cool very slowly in the mould; (one (1) week is the minimum time recommended)

(4) The castings are heat-treated in a closed furnace at not less than 600 F for at least 48 hrs maintaining control within plus or minus 25 F, to be followed by slow cooling.

CASE No. 1094

Inquiry: When may the impact test required by Par. U-142 be omitted in the case of vessels fabricated from deoxidized copper? In the revision of Par. U-142(**a**) dated July 26, 1948, the matter of minimum temperature for use of this material without impact tests was held in abeyance.

Reply: Because the material exhibits no significant loss of impact strength at temperatures as low as —325 F, the impact tests required for the material under Par. U-142(**a**) may be omitted for deoxidized copper complying with any of the specifications listed therefor in Table U-3, for service temperatures of —325 F and above. Impact tests of the weld metal shall be made as required by Par. U-142 (**b**) but the specimens with the notch adjacent to the weld may also be omitted. In all cases where the impact specimen bends without breaking the test shall be considered as meeting the requirements.

CASE No. 1095

Inquiry: When may the impact test required by Par. U-142 be omitted in the case of vessels fabricated from copper-silicon alloy material? In the revision of Par. U-142(**a**) dated July 26, 1948, the matter of minimum temperature for use of this material without impact tests was held in abeyance.

Reply: Because the material exhibits no significant loss of impact strength at temperatures as low as —200 F, the impact tests required for the material under Par. U-142(**a**) may be omitted for copper-silicon alloy material complying with any of the specifications listed therefor in Table U-3 for service at —200 F and above. Impact tests of the weld metal shall be made as required by Par. U-142 (**b**), but the specimens with the notch adjacent to the weld may also be omitted. In all cases where the impact specimen bends without breaking the test shall be considered as meeting the requirements. Because closer control of composition than that required by the approved specifications has been found to be effective in preventing significant loss of impact strength at least down to —325 F, the impact tests may be omitted, for material that conforms to Grade A of either Specification SB-96 or SB-98, provided either manganese or phosphorus has been added in an amount necessary for deoxidation and provided aluminum is not present in an amount in excess of 0.65 per cent, for use at temperatures of —325 F and above.

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions

of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the Code. They are published herewith with corresponding paragraph number to identify their location in the various sections of the Code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

Revise footnote (3) on page 2 of Section IX to read as follows:

(3) For example: A change from an E6010 to an E6012 or AN E7010 electrodes, PAIRS OF ELECTRODES, (E6010; E6011; E6012; E6013; E6015; E6016; E7010; E7011; and E7015; E7016) MAY HOWEVER, BE USED INTERCHANGEABLY SO THAT QUALIFICATION WITH EITHER ONE WILL QUALIFY BOTH, (Specifications SA-233 and SA-316 for Iron and Steel Arc-Welding Electrodes.) [or] A change from a G-60 to a G-45 or to a G-65 welding rod REQUIRES REQUALIFICATION. (Specification SA-251 for Iron and Steel Gas-Welding Rods.)

Under Q-101(b), P4, revise to read as follows:

P4 A change in filler metal from one ASME Classification Number[3] to another ASME Classification Number EXCEPT AS GIVEN IN NOTE 3.

Revise the following specifications to agree with the proposed revisions of similar ASTM specifications:

Plates	Tubular Products
SA- 30	SA-106
SA-203	SA-158
SA-285	SA-206
SA-301	SA-280
SA-302	SA- 53

Editorial

SA-201	SA- 83
SA-202	SA-178
SA-204	SA-192
SA-212	SA-209
SA-225	SA-210
SA-302	SA-213
SA-226	SA-249
SA-250	

Tentative

SA-201	SA-204
SA-212	SA-225

Revise the following specifications to agree with proposed revisions of similar ASTM Specifications

SA-182
SA-193
SA-194

Revise M-15 as follows:

The gage shall be connected to the steam space or to a steam connection to the water column by a [brass or bronze composition] syphon tube or equivalent device that will keep the gage tube filled with water. IF BRASS OR BRONZE COMPOSITION IS USED THE MINIMUM SIZE OF THE SYPHON TUBE SHALL BE $^1/_4$ IN. STANDARD PIPE SIZE, FOR OTHER MATERIALS THE MINIMUM INSIDE DIAMETER OF THE PIPE OR TUBING SHALL BE $^1/_2$".

Revise Par. P-332(c) to read as follows:

Code Symbol Stamps

Each boiler, superheater, waterwall and steel economizer to which the Code symbol is to be applied shall be fabricated by a manufacturer of boilers superheaters, water walls, or steel economizers who is in possession of a Code symbol stamp (see Fig. P-48), and a valid certificate of authorization, except as otherwise provided in Par. P-300 [which also covers piping].

[For equipment operating at temperatures above 800 F, the stamping may be applied to a name plate which is irremovably attached by welding to the part, provided such welding is stress-relieved.]

Permission to use the power boiler symbol stamp shown in Fig. P-49 [will be granted by The American Society of Mechanical Engineers to any manufacturer complying with the provisions of this Code who will agree, upon forms issued by the Society, that any part to which that symbol is applied will be constructed in full accorcance with the Code requirements and that he will not misuse or allow others to use the stamp by which the symbol is applied]. THE PRESSURE PIPING SYMBOL STAMP SHOWN IN FIG. P-41, AND THE BOILER ASSEMBLY SYMBOL STAMP SHOWN IN FIG. P-49 WILL BE GRANTED BY THE SOCIETY PURSUANT TO THE PROVISIONS OF THIS PARAGRAPH.

[In addition to the above, permission to use the symbol is limited to the period of time specified on the certificate of authorization.]

[Permission to use the pressure piping symbol stamp shown in Fig. P-41 or the boiler assembly stamp shown in Fig. P-49 will be granted by The American Society of Mechanical Engineers to any organization or individual complying with the provisions of this Code who will agree, upon forms issued by the Society, that any part to which the pressure piping symbol is applied, or that any boiler assembly to which the assembler's symbol is applied, will be in full accordance with the Code requirements and that he will not misuse or allow others to use the stamp by which the symbol is applied.]

[Any manufacturer complying with the foregoing provisions will be issued or reissued a certificate of authorization to use the symbol for a period of three years upon payment of an administrative fee. The certificate shall include the date of issue and date of expiration and shall be signed by the Chairman and Secretary of the Boiler Code Committee. The Society reserves the right to cancel or not to reissue the certificate any time upon failure of a manufacturer to comply with the provisions of the agreement under which the symbol was issued by notification and return of the current fee.]

ANY MANUFACTURER OR ASSEMBLER MAY APPLY TO THE BOILER CODE COMMITTEE OF THE SOCIETY, UPON FORMS ISSUED BY THE SOCIETY, FOR PERMISSION TO USE THE APPROPRIATE STAMP OR STAMPS, EACH APPLICANT MUST AGREE THAT IF PERMISSION TO USE ANY SUCH STAMP IS GRANTED, IT WILL BE USED ACCORDING TO THE RULES AND REGULATIONS OF THIS CODE AND THAT ANY SUCH STAMPS WILL BE PROMPTLY RETURNED TO THE SOCIETY UPON DEMAND, OR IN CASE THE APPLICANT DISCONTINUES THE MANUFACTURE OR ASSEMBLY OF THE ABOVE, OR IN CASE THE CERTIFICATE OF AUTHORIZATION ISSUED TO SUCH APPLICANT HAS EXPIRED AND NO NEW CERTIFICATE HAS BEEN ISSUED. THE HOLDER OF ANY SUCH STAMPS SHALL NOT PERMIT ANY OTHER MANUFACTURER OR ASSEMBLER TO USE HIS STAMPS.

PERMISSION TO USE SUCH STAMPS MAY BE GRANTED OR WITHHELD BY THE SOCIETY IN ITS ABSOLUTE DISCRETION. IF PERMISSION IS GIVEN, AND THE PROPER ADMINISTRATIVE FEE PAID, A CERTIFICATE OF AUTHORIZATION EVIDENCING PERMISSION TO USE ANY SUCH SYMBOL, EXPIRING DECEMBER 31, 1949, OR THE TRIENNIAL ANNIVERSARY DATE THEREAFTER, WILL BE FORWARDED TO THE APPLICANT. EACH SUCH CERTIFICATE WILL BE SIGNED BY THE CHAIRMAN AND SECRETARY, OR OTHER DULY AUTHORIZED OFFICER OR OFFICERS, OF THE BOILER CODE COMMITTEE. SIX (6) MONTHS PRIOR TO THE DATE OF EXPIRATION OF ANY SUCH CERTIFICATE, THE APPLICANT MUST APPLY FOR A RENEWAL OF SUCH PERMISSION AND THE ISSUANCE OF A NEW CERTIFICATE.

THE SOCIETY RESERVES THE ABSOLUTE RIGHT TO CANCEL OR REFUSE TO RENEW SUCH PERMISSION, RETURNING FEES PAID FOR PRO-RATED UNEXPIRED TERM.

THE BOILER CODE COMMITTEE MAY AT ANY TIME AND FROM TIME TO TIME MAKE SUCH REGULATIONS CONCERNING THE ISSUANCE AND USE OF SUCH STAMPS AS IT DEEMS APPROPRIATE, AND ALL SUCH REGULATIONS SHALL BECOME BINDING UPON THE HOLDERS OF ANY VALID CERTIFICATE OF AUTHORIZATION.

All steel stamps used for applying the symbol shall be purchased from the Society.

Revise Par. P-193(b) as follows:

first paragraph to remain (b); second paragraph changed to (c) and reworded to read: When tubes or holes are unsymmetrically spaced, the average ligament efficiency shall be not less than THAT GIVEN BY the following RULES, WHICH APPLY TO LIGAMENTS BETWEEN TUBE HOLES, AND NOT TO SINGLE OPENINGS. THIS PROCEDURE MAY GIVE LOWER EFFICIENCIES IN SOME CASES THAN THOSE FOR SYMMETRICAL GROUPS WHICH EXTEND A DISTANCE GREATER THAN THE INSIDE DIAMETER OF THE SHELL AS COVERED UNDER P-192. WHEN THIS OCCURS THE EFFICIENCIES COMPUTED BY THE RULES UNDER P-192 SHALL BE USED.

The rest of Par. P-193(b) as presently written shall follow in (c).

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

EJC Studies 1949 Employment Trends

THAT the Engineers Joint Council is an important step in the inevitable progress toward unity of the engineering profession, was demonstrated at its second meeting under the new EJC Constitution which has been formally approved by all five of the constituent societies. The Council announced the 1949 membership for its committees and heard reports on a variety of projects through which the EJC is serving as spokesman for more than 100,000 qualified engineers who are members of the five basic branches of engineering represented by its member societies.

EJC Committees

The scope of interests and measure of unity already achieved are impressive. EJC member societies are active on the following EJC committees: Constitution and By-Laws; Committee of Secretaries; International Relations; General Survey Committee; National Engineers Committee; Selective Service Committee; Engineers Co-Operating in Medical Research; Representative on UNESCO; Collective Bargaining by Engineers in Professional Work; Unity of the Engineering Profession; National Water Policy; Fuel Resources; Labor Legislation Panel; Science Legislation Panel; and Committee on National Military Establishment. Many of these committees were organized under the old agreement which created EJC as an interim agency to carry on the work of the dissolved American Engineering Council.

1949 Employment Situation

Among the reports heard by the EJC was that of the General Survey Committee which recently completed a study of 1949 employment programs for graduating engineers planned by industrial companies and government agencies. This committee was created early in 1949 to serve as a central fact-gathering agency on significant trends within the engineering profession. Its report on the 1949 employment picture with facts about starting salaries for inexperienced engineers and salaries of engineers 10 years or more out of school, provided new information on the economic status of the engineer.

Nearly 200 organizations who returned questionnaires reported that "they had hired 10,400 inexperienced engineering graduates in 1948 and estimated that they would hire 8175 or some 21 per cent less in 1949. For industrial companies, the decrease was 26 per cent to a total of 5700; for governmental agencies, 9 per cent to one of 2480. Agencies of the state governments actually expected a substantial increase. Estimated employment includes 1066 chemical or ceramic engineers, 1950 civil or structural, 1960 electrical, 2760 mechanical, aeronautical or industrial, 190 mining, and the remainder scattered," the report states. The full text of the EJC report is to be published in a later issue.

The status of the professional engineer in Federal civil service is currently under study by an EJC committee. In its preliminary report the committee stated that each of its members was gathering facts from employer and employee in his own field of engineering.

With regard to EJC endorsement of National Science Foundation legislation, the Council heard a report of the EJC Science Legislation Panel. On March 31, 1949, the EJC Panel submitted a statement before a Congressional hearing, presenting views of the engineering profession on National Science Foundation bills now before the House of Representatives. The Senate has recently passed its own bill. In its statement the Panel said: "The Engineers are vitally interested in basic scientific research and have consistently and actively endorsed legislation purporting to establish a National Science Foundation. The views of the engineers have been recorded repeatedly in statements submitted by this panel at public Congressional hearings, first to the Committee on Military Affairs of the United States Senate in October, 1945, and subsequently to the Committee on Interstate and Foreign Commerce of the House of Representatives in March, 1947, and May, 1948."

For 1949 the EJC Executive Committee will consist of the following: R. E. Dougherty, ASCE, chairman; H. G. Moulton, AIME; E. G. Bailey, ASME; J. E. Housley, AIEE; and L. W. Bass, AIChE.

File of Key Engineering Personnel Object of EJC Questionnaire

Engineers Selected Urged to Co-Operate

TO provide source material for a who's who in engineering research and development and other scientific projects for use by the National Military Establishment, the Engineers Joint Council, acting through The American Society of Mechanical Engineers, has accepted the task of providing the Office of Naval Research with the names, addresses, ages, and details of professional and scientific qualifications of 100,000 key engineers in all branches of American engineering.

The source file of key engineering personnel thus obtained will provide a valuable tool for solving a variety of technical personnel problems. Its use will diminish disturbances of the national economy, organization of industry, and the personal welfare of engineers, and provide a means by which national resources of technical personnel can be ascertained. The file will also point up weak spots which should be strengthened by education, training, and other means. As a national asset the body of facts will be available to private industrial, educational, and professional-society planning groups, and for other legitimate purposes.

A four-page questionnaire will soon be mailed to 100,000 engineers holding the grade of member or higher in 18 national professional engineering societies. The returns will be collected by the ASME and turned over to the Office of Naval Research of the National Military Establishment for classification.

The project is the result of a conference held in Washington, D. C., last fall attended by EJC representatives and many other engineering agencies, at which was discussed the need for a list of 25,000 key engineers working in research, development, and other scientific projects who could be called in on a full or part-time basis to work on the broad scientific programs of the National Military Establishment.

The task of collecting personal and professional data fell to the EJC as the largest joint agency of the engineering profession. ASME assumed administration of the project as contracting agent of the EJC.

The Engineers Joint Council points out that this will not be just another questionnaire, but one sent to engineers selected from the upper echelon of the profession. The data sought is not intended for general government use but will go directly to the engineering agencies of the National Military Establishment, who will make direct use of it. As the questionnaire will provide the key to opportunity to professional and patriotic service, engineers selected to receive it are urged to give it serious attention and to answer all questions fully.

UN to Sponsor First Scientific Conference

Topic: Conservation and Utilization of Resources

WORLD mobilization of natural resources techniques and know-how is the objective of the United Nations Scientific Conference on the Conservation and Utilization of Resources (UNSCCUR), to be held at Lake Success, New York, Aug. 17–Sept. 6, 1949.

In response to personal invitation from Trygve H. Lie, secretary general, United Nations, and to invitations sent to governments asking for selection of outstanding scientists, more than 450 engineers, scientists, and technicians from 30 countries have accepted invitations to prepare papers.

Already 231 papers dealing with new techniques for better use of land, water, minerals, forests, marine life, fuels, and energy resources, have been received.

UNSCCUR is a new departure for the United Nations because it brings together not representatives of governments but representatives of science and the engineering profession.

Broad Program Planned

The conference program will be divided into two parts. Approximately half of the program will be devoted to the interrelation of resources techniques through plenary meetings on subjects of general interest to engineers, scientists, technicians, economists, and resources administrators. In this portion of its work the conference will examine the state of the world's resources potential, measure its depletion, and delve into the legacy of its past waste and misuse. Under the general heading, "Using and Conserving Resources," estimates of the undiscovered oil and gas resources and the trends in the use of metals will be discussed.

The other half will consist of 60 section meetings during which specialists will exchange methods and experiences with specific problems and techniques. Subject by subject these meetings will cover forests, water, land resources, wildlife, fish, marine resources, fuels and energy, and mineral resources.

As in other United Nations meetings, the meeting will be conducted by simultaneous interpretations in the five official languages, English, French, Spanish, Russian, and Chinese.

Proposed by President Truman

The conference was proposed by President Harry S. Truman in September, 1946, in a letter to the U. S. Delegate to the Economic and Social Council. In making the proposal, President Truman emphasized the relation of the conference to the problems of underdeveloped areas, stating: "It is my hope that such a scientific conference would bring together all the new techniques of resource conservation and utilization particularly for the benefit of underdeveloped areas, since the problems of these areas represent the hopes of millions of people for freedom from starvation and for opportunity in life." President Truman proposed that the experts called together "would not necessarily represent the views of the governments of their nations, but would be selected to cover topics within their competence on the basis of their individual experience and studies."

Of special interest to mechanical engineers will be the section meetings under "Mineral Resources" and "Fuels and Energy." In a half-day meeting devoted to conservation in manufacture, such subjects as conservation of iron, steel, and nonferrous metals in production, treatment of gas wastes, will be taken up. Under the topic "Conservation by Substitution," substitution of light metals for steel and copper will be discussed, as well as possibilities of extracting mineral resources from the sea. Under "Fuels and Energy," the program lists such topics as underground gasification, synthetic-fuels production, new techniques in the coal industry, new developments in electric power, and others.

600 Attend International Congress in Cairo

MORE than 600 engineers from 26 countries participated in the Second International Technical Congress held in Cairo, Egypt, March 20–26, 1949, the purpose of which was a "discussion of technical and special problems that are of primary importance for the consolidation of peace." The Congress was sponsored by the World Engineering Conference.

W. H. Carson, Mem. ASME, attended the congress as honorary vice-president of The American Society of Mechanical Engineers and as official delegate of the Engineers Joint Council. Other American delegates were: Charles R. Enlow, agricultural attaché, U. S. Embassy, Ankara, Turkey; T. W. Mermel, U. S. Bureau of Reclamation, Washington, D. C.; Edwin R. Raymond, agricultural attaché, U. S. Embassy, Cairo; Commander Robert D. Thorson, U. S. Navy, assistant Naval attaché, U. S. Embassy, Cairo; Col. Theodore A. Weyher, assistant military attaché, American Legation, Berne, Switzerland; and Ray P. Walters, representing the American Institute of Mining and Metallurgical Engineers.

More than 30 resolutions were adopted during the Congress. These reaffirmed the objectives of the first technical congress held in Paris in 1946 to be those of more research in human problems, decisive action against want, and international co-operation in dissemination of technological knowledge. The delegates felt that progress since 1946 had been too meager, and listed as reasons the devastation caused by the war, the rapid increase of new needs, and the international barriers to movements of individuals and access to raw materials and machines. It was agreed that more attention should be given by international organizations to the study of fuels and production of power; that knowledge on extraction and peaceful use of nuclear material should be more widespread, and that an international body should be set up to collect and serve as a clearinghouse for information on control and use of water resources. Also accepted as one of the major objectives of engineers was that technical progress should be directed to the greatest possible saving of human primary labor and the economy of expendable raw materials.

ECPD Junior Engineer's Guide

A GUIDE for the professional life of the young engineer, the work of the late William E. Wickenden, for 18 years president of Case Institute of Technology, Cleveland, Ohio, has just been published by the Engineers' Council for Professional Development.

The book, titled, "A Professional Guide for Junior Engineers," was begun by Dr. Wickenden in 1942, and his untimely death in 1947 came before he completed his final version. G. Ross Henninger, then editor of *Electrical Engineering*, and now director of publications of the Illuminating Engineering Society, undertook the task of editing the final version.

The book presents the philosophy and engineering ethics a young engineer needs for success as viewed by Dr. Wickenden. It opens with a historical survey of the engineer's heritage, going back to Tubal-cain, and traces the beginnings of engineering societies. From there Dr. Wickenden traces the engineering profession through its every aspect, what the young engineer can expect to find, the difference between a trade and a profession, professional relationships, finally ending the book with his most famous essay on a philosophy of life, "The Second Mile," known to engineers the world over.

Addenda to the book are: "Faith of the Engineer," a credo accepted by the ECPD, a recommended Reading List for Junior Engineers, A Self-Appraisal Questionnaire, and the Canons of Ethics for Engineers.

The Engineers' Council for Professional Development, founded in 1932, is a conference of engineering bodies, organized to enhance the professional status of the engineer through the co-operative efforts of national organizations concerned with the professional, technical, educational, and legislative phases of engineers' lives.

Copies may be obtained from the Engineers' Council for Professional Development, 29 West 39th Street, New York 18, N.Y., for one dollar. Quantity purchases are available at a discount.

Engineering Societies Library

AMONG the services rendered by the Engineering Societies Library is the translation service which in the past 25 years has earned an enviable record and each year receives hundreds of requests for translations. The group has translators for 25 languages who are experts in various fields of engineering, make translations and check them for accuracy and readability; 4500 translations

have been indexed; and the charge for translations made, helps to defray the costs of the general service. The rates per hundred words for English translations of technical articles of ordinary difficulty are: German, French, Italian, and Spanish, $1.50; Russian, Dutch, Portuguese, Danish, and Swedish, $2. Quotations are submitted on request for Japanese, Chinese, Finnish, etc. Members of the Founder Societies who order work for their personal use and pay by personal check will receive a discount of 20 per cent on translations.

The other services available include a Service Bureau which serves persons who lack the time to use the reading room, or live too far away. This group makes literature searches and handles questions on any engineering subject. The service ranges from recommending books on a specific subject to the preparation of comprehensive annotated bibliographies. The Library is also prepared to handle requests for photostats and microfilm.

Gilbreths' Biography Published

THE ASME Biographical Series' special subscription edition of "Frank and Lillian Gilbreth: Partners for Life," by Edna Yost, with a foreword by A. A. Potter, Hon. Mem. ASME, dean of engineering, Purdue University, is now available. It is an impressive story of the Gilbreths' work in motion study, of the "Gilbreth System," of Mrs. Gilbreth's valiant continuation of her husband's work after his death in 1924. In 1944 she received from The American Society of Mechanical Engineers and the American Management Association the Gantt Medal presented jointly to her and to Frank Gilbreth for their pioneer work in scientific management. The story of the Gilbreths' professional career is only part of the biography. Their domestic partnership was as fully realized.

The special subscription edition is bound in an attractive, durable, dark-green cloth, with gilt-top pages, silk headbands, the title stamped in gold, amply illustrated, and is priced at $4.40 to ASME members, $5.50 to nonmembers. A review of the book by J. M. Juran, Mem. ASME, appears on page 610 of this issue.

Engineers Study Price Structure

TWO factors in the price structure of industry directly influenced by what the engineering profession contributes to the arts of production and distribution, were singled out for concentrated study by more than 60 representatives of industry and engineering societies at a meeting called by the Management Division of The American Society of Mechanical Engineers in New York, N. Y., March 23, 1949.

Although the relationship between productivity and price is quite clear, the present situation of high prices and mounting employment calls for a vigorous restudy and restatement, according to the ASME Management Division. Since productivity was essentially a responsibility of mechanical engineers, the first objective agreed upon was the development of new facts which would deserve to re-establish and reaffirm this relationship.

The second objective on which the group concurred was the cost of physical distribution of products and how it affects price. Two recent developments, the U. S. Supreme Court's basing point decision and the 50 per cent postwar increase in rail rates, point up the urgency of such a study. According to Fenton B. Turck, Mem. ASME, who presided, these developments have introduced an inflexible factor in the price structure which must be clearly understood if corrective measures are to follow.

In a general discussion during which many suggestions were made on how to implement the study, it was agreed to consider only the productivity and distribution factors in the pricing picture. A questionnaire will soon be mailed to co-operating companies as the first step in the project.

Industrial Fire Prevention Literature Available

A VAST fund of engineering information on fire protective and preventive features of design and construction in the form of standards, reports, and recommended practices is available free from the engineering and research agencies of the National Board of Fire Underwriters, New York, N. Y.

Organized in 1866 by capital-stock fire-insurance companies to reduce the incidence of danger by fire, the Board has a current membership of more than 200 company members. Of particular interest to engineers is the Board's Committee of Fire Prevention and Engineering Standards, which conducts municipal inspections, probes fire defenses of cities, studies industrial operations and processes, and prepares standards for safe operation. Recently a new research division was organized to study hazards introduced by industrial use of new chemicals.

The Board sponsors among its other activities the annual Fire Prevention Week which serves to bring the causes of fire to public attention, Spring Clean-Up Week, and co-operates with other agencies in promoting forest-fire prevention and farm safety. Its fire-prevention posters are known all over the country.

As a service to industry and the public, all of the Board's reports and standards are distributed free of charge. In a recent bulletin the Board lists more than a hundred standards and recommended safeguards covering fire extinguishing appliances and auxiliaries, flammable liquids, combustible solids, hazardous gases, explosive dust, electrical equipment and safe construction. The bulletin also lists research reports on fire hazards of the plastics industry and in the heat-treatment of metals, and special technical reports on such disasters as the Texas City explosion and fire.

The bulletin and standards are free and may be obtained from the National Board of Fire Underwriters, 85 John Street, New York 7, N. Y.

Kreisinger Laboratory Dedicated

THE Kreisinger Development Laboratory, located at the plant of Combustion Engineering-Superheater, Inc., Chattanooga, Tenn., was dedicated on April 22, 1949, by J. V. Santry, Mem. ASME, president of the company. The laboratory honors the memory of the late Henry Kreisinger, Mem. ASME, one of the pioneers of pulverized-fuel firing. In attendance for the ceremony were many prominent business and government leaders and company executives.

The two buildings which comprise the laboratory were completed in 1946. They are fully equipped to handle routine testing for experimental work. Facilities are also available for overhauling and calibrating test instruments used for field testing purposes.

Joining the research department of Combustion Engineering Company in 1920, Mr. Kreisinger devoted most of his time in the early years to the development of pulverized-coal firing and the use of water cooling in furnaces. His work for the company in later years included supervision of research and testing with respect to all types of fuel-burning equipment, investigations of furnace temperatures, and many related subjects. Planning for the company's new development laboratory occupied much of his time during his later years, and before his death on May 7, 1946, he was able to see many of these plans nearing completion.

In 1943 he received the Percy Nicholls Award which is given jointly by the Coal Division of the American Institute of Mining and Metallurgical Engineers and Fuels Division of The American Society of Mechanical Engineers for notable scientific or industrial achievement in the field of solid fuels.

Joseph Bramah Bicentenary

THE bicentenary of the birth of Joseph Bramah, eighteenth-century British engineer and inventor, was celebrated by ceremonies in Wentworth Castle, Stainborough, York, England, May 9, 1949. Joseph Bramah, born a farmer's son in 1749, was regarded as the mechanical genius of his time when he died in 1814. Among his achievements are the design of one of the first rotary pumps, invention of a safety lock and a hydraulic press. In 1785 he suggested screw propulsion of ships, and hydraulic transmission of power. The celebration, sponsored by the Sheffield Trades Historical Society, consisted of addresses on the life and work of Joseph Bramah, and an exhibit of some of his inventions and patents.

* * *

THE Western Society of Engineers celebrated its eightieth anniversary and the dedication of its new headquarters at 84 East Randolph Street, Chicago, Ill., in the John Crerar Library property, on May 25, 1949.

Codes and Standards

Unified National Plumbing Code Sought to End Confusion in Plumbing Field

FORMULATION of a unified national plumbing code which will incorporate best features of five plumbing codes currently competing on the national level, and which can be accepted by all sections of the country, was the purpose of a meeting in Washington, D. C., May 10 and 11, 1949, attended by representatives of government health and safety agencies, plumbing industry, and technical societies.

The meeting was called by The American Society of Mechanical Engineers and the American Public Health Association as the first step in correcting the chaotic situation in the plumbing field caused by more than 1600 local pumbing ordinances which differ among regions and even sections of the same national region. For industry and the public, this lack of uniformity has meant increased cost of plumbing installations, and substandard health and safety provisions, in some cases.

Organizations who also sent representatives were: The Housing and Home Finance Agency, and the National Bureau of Standards, both of the U. S. Department of Commerce; Western Plumbing Officials Association; Conference of State Sanitary Engineers; American Society of Sanitary Engineering; and the Building Officials Conference of America.

Five Major Plumbing Codes

The proposed unified national plumbing code is to be based on three existing codes and drafts of two codes now being formed. The existing codes are: (1) American Standard Plumbing Code drafted by a committee sponsored by the ASME with the co-operation of the APHA; (2) the Uniform Plumbing Code of the Department of Commerce; and (3) the Western Plumbing Officials Code which is now in force in 13 western states. The two codes in process of compilation are those of the Building Officials Conference of America, and the American Society of Sanitary Engineers.

Following the election of F. W. Dawson, Mem. ASME, dean, college of engineering, University of Iowa, Iowa City, Iowa, as chairman, and V. T. Manas, Mem. ASME, chief, Uniform Plumbing Code Committee of the Department of Commerce, as executive secretary, the meeting began by defining basic plumbing terms. It was the consensus that the new code should be prefaced by a statement of principles of good plumbing practice which could be used by legislators in formulating plumbing statutes, and that the code proper should be a compilation of best features of existing national codes. Statement of twelve of the principles was formulated and accepted, and ten others were considered for further study. To aid in the detailed work of selecting code provisions, it was decided to prepare a comparative chart listing parallel requirements of the five codes so that members of the group could vote on which wording would be used in the new document.

The group also agreed that the American Standard Plumbing Code of minimum requirement drafted by a committee representing 30 co-operating organizations under the procedures of the American Standards Association and the Department of Commerce code, already harmonized with it, and would serve as the groundwork for the new unified national code. Copies of the ASA code (A40.7-1949) are available at $2.50 from the ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y.

Boiler Code Committee Meets in Chicago

MORE than 125 engineers representing the steam-power and pressure-vessel industries were guests at the regular May meeting of the Boiler Code Committee of The American Society of Mechanical Engineers held in the Sheraton Hotel, Chicago, Ill., May 17, 1949, at the invitation of the ASME Chicago Section.

Each year the Boiler Code Committee holds one meeting away from New York, N. Y., where it conducts most of its business, to allow engineers in other sections of the country to witness its operations. In recent years such meetings have been held in Los Angeles and Boston.

One of the first actions taken by the Committee was a resolution acknowledging the "constructive and valuable contributions" of Samuel Kepner Varnes, member of the committee since 1936, who died on April 19, 1949, and expressing sympathy to members of his family.

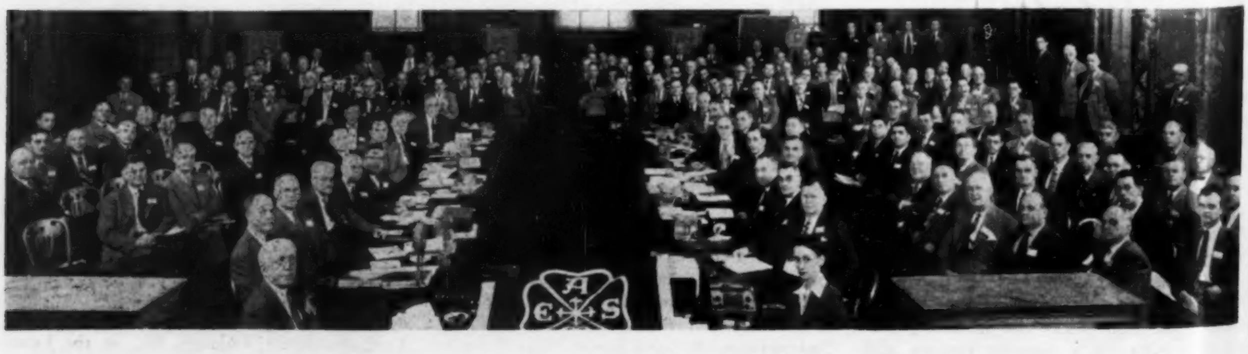
On the committee's agenda for May were cases covering staybolts, refrigerated wall storage tanks, proposed working stresses for nickel, copper, and aluminum alloys, and others. Midwest engineers watching the committee in action were impressed by the diligence with which inquiries brought before it by users of the ASME Boiler Code were investigated and discussed before actions were taken.

Committee to Interpret New Plumbing Code

WITH the completion of the new American standard Plumbing Code (ASA A40.7-1949), a small working group has been established by The American Society of Mechanical Engineers and The American Public Health Association, sponsors of the new code, to answer inquiries about provisions of the code.

Members of the Committee, all of whom were active in formulating the code, are: A. H. Morgan, chairman, Mem. ASME, director, division of building management, Department of Public Works, New York, N. Y.; M. Warren Cowles, health officer, department of filtration, Hackensack Water Company, New Milford, N. J.; F. W. Dawson, Mem. ASME, dean, college of engineering, University of Iowa, Iowa City, Iowa; C. Holmquist, formerly director, division of sanitation, State Health Department, Albany, N. Y.; and V. T. Manas, Mem. ASME, housing and home finance agency, U. S. Department of Commerce, Washington, D. C.

Request for interpretation should be addressed to the Plumbing Code Interpretation Committee, ASME, 29 West 39th Street, New York 18, N. Y.



REGULAR MEETING OF ASME BOILER CODE COMMITTEE, CHICAGO, ILL., MAY 17

Proposed Revision to Safety Code for Elevators Completed

Public Comment Requested

THE preliminary draft of a proposed revision to Rule 217 of the American Standard, "Safety Code for Elevators, Escalators, and Dumbwaiters," covering capacity and loading, has been completed and is now being distributed to the public for review and comment. Comments should be addressed to Sullivan Jones, chairman, Sectional Committee for Safety Code for Elevators, c/o The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

The proposed revision follows:

Rule 217 Capacity and Loading

a For passenger elevators having platform areas not exceeding 50 sq ft, the contract load shall be not less than determined by the following formula

$$L = 0.667A^2 + 66.7A$$

For platform areas exceeding 50 sq ft, the contract load shall be not less than

$$L = 0.0467A^2 + 125A - 1367$$

where L = contract load in pounds, and A = inside net platform area in square feet.

Curves A and B in Figs. 4 and 4A show graphically the contract loads for various inside net platform areas.

Table 7 shows the maximum inside net platform area for the most common contract loads.

TABLE 7 MAXIMUM INSIDE NET PLATFORM AREA FOR THE MOST COMMON CONTRACT LOADS

Contract load	Inside platform area	Contract load	Inside platform area
500	7.00	4500	46.2
600	8.3	5000	50
700	9.6	6000	57.7
1000	13.25	7000	65.3
1200	15.6	8000	72.9
1500	18.9	9000	80.5
1800	22.1	10000	88.0
2000	24.2	12000	103.0
2500	29.1	15000	125.1
3000	33.7	18000	146.9
3500	38.0	20000	161.2
4000	42.2	25000	196.5

b The minimum contract load for freight elevators shall be based only on the weight and class of the load to be handled, and such elevators shall be designed for the class of loading for which they are used. This code recognizes three classes of loading for freight elevators as follows:

Class A: General freight loading: Where the load is distributed and the weight of any single piece of freight or of any single hand truck and its load does not exceed $1/4$ the contract load of the elevator. With this type of loading the load is handled on and off the car platform manually or by means of hand trucks. For this class of loading, the contract load shall be at least 50 lb per sq ft of inside net platform area.

Class B: Motor-vehicle loading: Where the elevator is used solely to carry a single automobile truck or a single passenger automobile. For this type of loading, the contract load shall be at least 35 lb per sq ft of inside net platform area.

Class C: Industrial truck loading: Where the load is handled on and off the car platform by means of industrial power trucks or by hand trucks having a loaded weight exceeding $1/4$ the contract load of the elevator. With this type of loading, the industrial truck may deposit its load on the elevator platform; or the truck and its load may be carried on the elevator platform; or the industrial truck may be used to move loaded trailers on or off the elevator platform. When the industrial truck and a load of material are to be carried simultaneously, the weight of the truck, plus the material handled shall not exceed the contract load of the elevator.

NOTE: In the design of the elevator car and its guide rails and their supports, together with the capacity of the brake and the traction relation, consideration should be given to the maximum static load imposed on the elevator car by each of the methods outlined in handling the load on and off the elevator platform.

c Every elevator shall have a metal capacity plate securely fastened in place in a conspicuous place inside the car, indicating the contract load in pounds (see also 217e5).

For passenger elevators the letters and figures shall be not less than $1/4$ in. in height, and for freight elevators not less than 1 in. high.

For freight elevators the capacity plate shall also designate in lettering not less

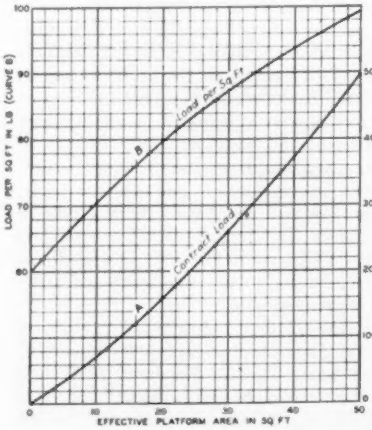


FIG. 4 CONTRACT-LOAD GRAPH FOR EFFECTIVE PLATFORM AREAS FROM 0 TO 50 SQ FT

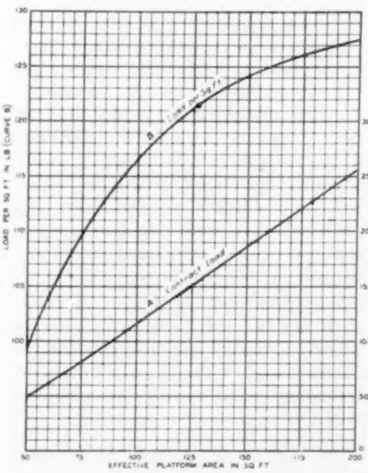
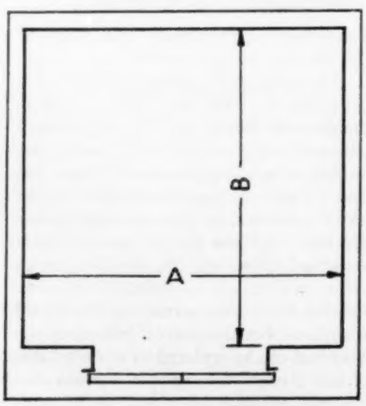
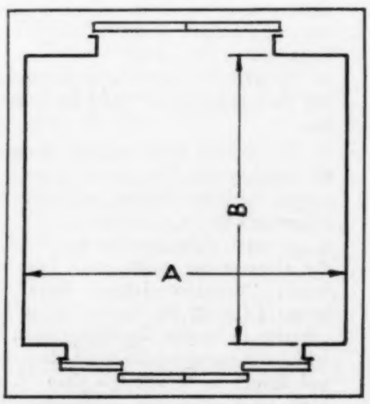


FIG. 4A CONTRACT-LOAD GRAPH FOR EFFECTIVE PLATFORM AREAS FROM 50 TO 200 SQ FT





(*Left to right*) FIGS. 5 AND 6 INSIDE NET PLATFORM AREA = A × B

than $^1/_2$ in. in height whether the elevator is designated for general freight loading, motor-vehicle loading, or industrial-truck loading, as outlined in paragraph *b*.

A metal sign shall be conspicuously located in every freight elevator, except elevators permitted by Rule 217d to carry employees, reading in letters not less than $^1/_2$ in. high: "This is not a passenger elevator. No person other than the operator or those necessary to handle freight are permitted to ride on this elevator."

A metal plate shall be securely fastened in a conspicuous place to the crosshead of each elevator and shall bear the following information:

1 The weight of the complete car including the car safety and all auxiliary equipment attached to the car.
2 The contract load and speed.
3 The cable data required by Rule 230b.
4 The manufacturer's name and date of installation.

Car capacity and crosshead plates shall have the letters and figures stamped in, etched, or cast on the surface of the plate.

d Freight elevators shall not be used to carry passengers except that by special permission of the enforcing authority they may be used to carry employees, provided the elevators meet the requirements for power passenger elevators specified in Rules 217a "Contract Load," 120 "Hoistway Doors," and 121 "Hoistway-Door Interlocks," and provided that the car is completely enclosed above the 6 ft level and on the top with solid enclosure or with open-work enclosures which will reject a ball 2 in. in diameter, and provided that each car opening is equipped with a car gate or door and a car gate or door electric contact.

e Power passenger and freight elevators shall not be used for carrying safes or other one-piece loads greater than the contract load of the elevator unless the following requirements are complied with:

1 A locking device shall be provided which will hold the car at any landing independently of the hoisting cables while the safe or other object is being loaded or unloaded.

2 The locking device shall be so designated that it cannot be unlocked unless the entire weight of the car and load is suspended on the cables.

3 The wrench or other device for operating the locking device shall be removable.

4 The locking device shall be designed to withdraw the bars should it come in contact with the landing locks if the car is operated on the up motion.

5 A metal plate shall be provided in the elevator car which shall bear the words "Capacity Lifting Safes" in letters followed by figures giving the capacity in pounds for lifting safes for which the machine is designed, the letters and figures to be not less than $^1/_4$ in. high, stamped, etched, or raised on the surface of the plate.

6 The car platform, car frame, sheaves, shafts, cables, and locking device shall be designed for the specified "Capacity Lifting Safes" with a factor of safety of not less than 5.

7 The car safeties shall be designed to stop and hold the specified "Capacity Lifting Safes" with the cables intact.

8 Where there is a passageway under the hoistway (see Rule 109d) the machine shall be designed to operate with the "Capacity Lifting Safes" at slow speed and the car safety shall be designed to stop and hold the car and "Capacity Lifting Safes" independently of the cables.

9 For traction machines, where necessary to secure adequate traction, additional counterweight shall be added, so that the total overbalance is at least equal to 45 per cent of the "Capacity Lifting Safes."

f The locking device specified in Rule 217e-1, shall be provided for any passenger elevator installed for carrying safes or other one-piece loads which exceed 75 per cent of the contract load.

g The "Capacity Lifting Safes" of any passenger-traction elevator shall not exceed $1^1/_2$ times the contract load of the elevator.

h All elevator machines equipped for carrying safes or other one-piece loads greater than the contract load of the elevator shall be provided with a special switch near the machine for operating under such conditions.

Unified Screw Threads Standard Available

Consumer Co-Operation Urged

WITH the observation that there is no end to the development and improvement of an active standard, the sponsors of the Unified and American Screw Threads Standard (ASA B1.1—1949), just published by The American Society of Mechanical Engineers, introduce what is perhaps the most important standardization achievement of the century. The standard harmonizes two stubborn screw-thread traditions which have gone their own way for nearly a hundred years without compromise. So basic are screw threads to industry, so enormous the economic stakes involved in inventories and machine tools, that it took two world wars, huge wastes in time, money, and life, and years of negotiations before the Whitworth and Sellers screw-thread forms could be altered sufficiently to make them interchangeable.

The new standard is issued as a revision of the 1935 American Standards and includes the Unified Screw Threads Standards of Canada and the United Kingdom agreed upon in Washington, D. C., in November, 1948. Since the two standards are identical for all practical purposes, both appear in the same numerical tables. The Unified Standards are distinguished by use of bold-face type.

60-Degree Angle Retained

The new basic screw-thread form, with an angle of 60 deg, has a rounded root in the screw. The crest of the screw may be either flat or rounded. The new form is interchangeable with the old and can be produced with the customary type of tools having flat crests when new. Six classes of threads are provided. Each class is characterized by the amount of tolerance, or tolerance and allowance specified. Classes 1A, 2A, and 3A apply to screws, and classes 1B, 2B, and 3B apply to nuts.

Transition to the new screw threads should not be difficult because the old classes of the 1935 Standard can be replaced by the combination of new classes: for example, the old class 1 by the new 1A with 1B, class 2 by 3A with 2B, and class 3 by 3A with 3B.

In addition to 41 page-length numerical tables, the new standard contains an historical account of its development, illustrates screw-thread forms, lists formulas upon which tables are based, describes thread series, and suggests applications.

Copies may be obtained from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y. Price is $3.

Most Significant Modification

To minimize misunderstanding during change-over and to encourage co-operation of users, the Committee responsible for the new standard recently sent the following message to industry:

The most significant modification in the Unified and American Screw Threads Standard is the addition of classes 2A and 2B.

Class 2A is an external thread classification which provides an allowance or clearance between its maximum metal condition and the maximum metal condition of any class of internal thread into which it assembles. This clearance minimizes galling and seizing in high-cycle wrenching and high-temperature applications. It also accommodates plating when required. Class 2A is recognized as standard practice for production of screws, bolts, and other threaded fasteners. Class 2B is a realistic approach to the tolerances required in the production of standard nuts.

Changing to classes 2A and 2B does not affect strength or interchangeability. Components are mechanically and functionally interchangeable in any combinations of the old and new classes.

Specification and adoption of these new classes of thread into actual practice will require restraint on the part of the users in order to afford manufacturers opportunity for reduction of present inventories of finished product and the working off of current stocks of tools and raw materials.

To implement change-over to the new classes of thread, users for an indeterminate period specify the new classes but permit the old classes as optional. Conversely when speci-

fications are not changed, users should accept the new classes as optional.

Producers and users have agreed that implementation of the new standards should proceed as rapidly as transition can be effected, and that inspection should be governed accordingly. They recommend, however, that for the time being neither the new nor the old classes as they apply to screws, bolts, nuts, and similar threaded fasteners, should be mandatory except for specific applications agreed upon by consumer and producer.

Steel Pipe Flanges

A SUPPLEMENT to the American Standard, "Steel Pipe Flanges and Flanged Fittings" (ASA B16e5-1939), containing revised pressure-temperature ratings for carbon, carbon-molybdenum, and equivalent steel pipe flanges and flanged fittings, has been published recently by The American Society of Mechanical Engineers.

The revised ratings replace those given in the 1939 standard and the American War Standard issued in 1943, and are intended as an interim measure decided upon to end confusion created in industry by the two standards now in use. The committee which drafted the supplement is currently working on a study of temperature-pressure ratings which is not expected to be completed for several years.

The 10-page supplement contains five tables, four of which replace Tables 6 to 11 of the 1939 standard, and the fifth gives the minimum wall thicknesses of welding-end valves.

Supplement No. 1 (ASA B16e6-1949) may be obtained from the ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y. Price is 40 cents.

Pipe Fittings Standards

TWO NEW American Standards have just been published by The American Society of Mechanical Engineers. The first is the American standard, "Brass or Bronze Screwed Fittings, 250 Lb," which covers 90 and 45-deg elbows, tees, crosses, couplings, reducing tees, and 90-deg reducing elbows for nominal pipe sizes of $^1/_2$ to 4 in.

The new standard was originally drafted by the Manufacturers Standardization Society of the Valve and Fittings Industry in 1930, to represent the most economical practice considered suitable for 250 lb pressure rating. In 1944 the original industry standard was revised and submitted to the American Standards Association. The standard sells for 35 cents.

The second standard published is the American standard, "Ferrous Plugs, Bushings, and Locknuts," which covers square-head plugs for nominal pipe sizes from $^1/_2$ to $3^1/_2$ in.; bar or slotted-head plugs for pipe sizes 4 to 8 in.; countersunk plugs for pipe sizes $^1/_8$ to 4 in.; and outside head, inside head, and face bushings ranging in sizes from $^1/_4 \times {}^1/_2$ to 8×6 in.

The new standard brings together under one cover American standards, "Pipe Plugs, B16e2-1936," and "Pipe Bushings and Locknuts, B16.14-1943," formerly published separately. It sells for 40 cents a copy.

Both standards were sponsored under the procedure of the American Standards Association by the Heating, Piping, and Air Conditioning Contractors National Association, the Manufacturers Standardization Society of the Valve and Fittings Industry, and The American Society of Mechanical Engineers. Copies may be ordered from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y.

Welding

A REVISION of the American Welding Society's 1942 standard, "Welding Terms and Definitions," A3.0-49, has just been published. The 50-page standard is the result of three years' work of a committee of 19 representatives of industry, government agency organizations, and research institutes. The first 25 pages are devoted to an alphabetical listing of the terms, and the remaining pages to line illustrations clarifying the definitions. Cost per copy is $1.

As part of the same project the AWS revised the standard, "Master Charts of Welding Processes and Process Charts." This standard, consisting of five charts, classifies the various welding processes and delineates the variations of each. Price is 35 cents per set. Copies may be obtained from American Welding Society, 33 West 39th Street, New York 18, N. Y.

Engineering Literature

Investment Casting

"ESL Bibliography No. 3," a list of 111 selected references to books and articles relating to precision investment casting by the lost-wax process, has just been compiled by the Engineering Societies Library, New York, N. Y. Theory, design problems, specific-industrial applications, and factory and production methods are all covered in the annotated references. Short descriptive articles and patent references have been omitted. Some historical references have been included to give a review of the application of this process in art and dental work.

The bibliography may be purchased from the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y. Price is $2.50.

Air Conditioning

THE 1949 edition of the Heating, Ventilating, and Air Conditioning Guide recently published, contains a 992-page technical-data section, and a 392-page catalog section, and is the largest issued by the American Society of Heating and Ventilating Engineers. Many special features and numerous revisions which bring the technical data up to date with current practice and the most recent research, were achieved through the co-operation of more than 40 members and many other authorities.

The list of codes and standards applicable to heating, ventilating, and air-conditioning practice has been enlarged so that it now includes 115 which are of importance to the practicing engineer in this field. Information is given on the latest available edition of each code, together with the address of the organization from which it may be obtained.

The Guide is priced at $7.50 and is available from ASHVE, 51 Madison Avenue, New York 10, N. Y.

Heat Transfer and Fluid Mechanics

TWENTY-TWO papers on heat transfer and fluid mechanics presented before the Heat Transfer and Fluid Mechanics Institute, Berkeley, Calif., June 22-24, 1949, have been published by The American Society of Mechanical Engineers as a service to the engineering profession. The papers appear in an 8×11-in. spiral-bound book complete with charts, photographs, and bibliography.

The Institute, sponsored by various engineering colleges in California and by sections of several engineering societies, was organized in 1948 to promote papers of high technical caliber in the fundamentals of heat transfer

Meetings of Other Societies

July 13
American Society of Civil Engineers, summer convention, Hotel Del Prado, Mexico City, Mexico

Aug. 23-26
American Institute of Electrical Engineers, Pacific general meeting, Fairmont Hotel, San Francisco, Calif.

Sept. 6-9
American Institute of Chemical Engineers, Montreal (regional) meeting, Mount Royal Hotel, Montreal, Can.

Sept. 19-23
American Chemical Society, 116th national meeting, Atlantic City, N. J.

Sept. 19-23
Illuminating Engineering Society, national technical conference, French Lick Springs Hotel, French Lick Springs, Ind.

Sept. 26-28
Illinois Institute of Technology, University of Illinois, Northwestern University, American Institute of Electrical Engineers, and Institute of Radio Engineers, 1949 national electronics conference, Edgewater Beach Hotel, Chicago, Ill.

(For ASME Calendar of Coming Events see page 628)

and fluid mechanics phenomena which are basic to many engineering activities.

Papers presented before the 1949 meeting of the Institute cover such subjects as: Boundary-layer effect on spinning spheres; analysis of short-length liquid sprays; heat-transfer coefficients in beds of moving solids; heat-transfer coefficients and friction factors for air flowing in a tube at high surface temperatures; and others.

The Institute volume may be obtained from the ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y. Price is $5.

Notes on Coming Meetings

THE week of Oct. 10, 1949, has been selected for the first Pacific area national meeting of the American Society for Testing Materials, to be held at the Fairmont Hotel, San Francisco, Calif. Some 70 technical papers will be presented dealing with the field of engineering materials and related subjects.

SOUTHWEST Air-Conditioning Exposition of the International Heating and Ventilation Exposition will be held at the State Fair Park, Dallas, Texas, Jan. 23 to 27, 1950, sponsored by the American Society of Heating and Ventilating Engineers, simultaneously with their 56th annual meeting. Dallas is the center of an unprecedented surge of new enterprise that is sweeping the area, and practically all new building throughout the Southwest is air-conditioned. A substantial number of exhibitors have already engaged space at the Dallas exposition which will assure a well-rounded display covering every phase of the equipment involved in air-conditioning problems. It is the only exposition of its kind to be held during 1950.

THE first Plant Maintenance Show and exposition devoted exclusively to cost reduction through improved installation, operation, and maintenance of equipment and services in factories, warehouses, and other plants, will be held in the Public Auditorium, Cleveland, Ohio, Jan. 16–19, 1950. Concurrently with the show a four-day conference on plant maintenance methods will be held, with L. C. Morrow, editor, *Factory Management & Maintenance*, as general chairman.

THE 31st National Metal Congress and Exposition to be held in the Public Auditorium, Cleveland, Ohio, Oct. 17 through Oct. 21, 1949, will have as its theme, "Economy in Production."

Dramatic principles of cost cutting will take the form of "know-how" during the special technical and education sessions of the Metal Congress; the "show-how" of production economy will be graphically demonstrated by the exhibitors who, with either materials, equipment, or processes, will illustrate the proper application and most efficient operation of their product as a contribution to savings in production.

Awards

Swiss Engineer Receives First Wallace Clark International Award

THE first presentation of the Wallace Clark International Award "for distinguished contributions to scientific management in the international field" was made to Dr. Hugo de Haan, secretary general, Comité International de l'Organisation Scientifique, at a dinner meeting of American management engineers held at the Hotel Statler, New York, N. Y., May 17, 1949.

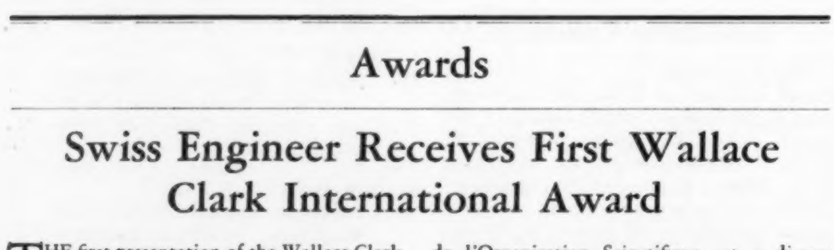
Dr. de Haan, who during the war and until

HUGO DE HAAN, SECRETARY CIOS, FIRST RECIPIENT OF THE WALLACE CLARK INTERNATIONAL AWARD

1948 was head of the International Red Cross Central Information Bureau of Prisoners of War in Geneva, Switzerland, has been active in the field of international management since 1922 when he joined the International Labor Office of the League of Nations. He was organizer of the international management conferences on Budgetary Control in 1931, and management research in 1933. Following his first visit to the United States in 1932 as a Rockefeller fellow, he wrote "American Planning," which was published by the Academy of Political and Social Sciences.

The Wallace Clark International Award was established recently by The American Society of Mechanical Engineers, American Management Association, Society for the Advancement of Management, and the Association of Consulting Management Engineers, as an annual award to be presented through the National Management Council of the United States. The award perpetuates the memory of the late Wallace Clark, Fellow ASME, who during the period between the wars was the foremost proponent of American concepts of scientific management and industrial democracy in Europe. His philosophy, expressed simply as "remove all obstacles to a free flow of work...from the bottom up, not from the top down," which he preached and applied in Poland, Germany, France, and other European countries, was an exciting concept to European engineers struggling with the task of reviving disrupted industry following the first world war. An account of Wallace Clark's European work was published in "The Challenge to American Know-How," written by his wife, Pearl Franklin Clark. (See page 124, February, 1949, issue of MECHANICAL ENGINEERING.)

H. B. Maynard, Mem. ASME, president, National Management Council, presided at the presentation ceremonies. Speaking as former associates, Erwin H. Schell, ASME; Alvin E. Dodd, AMA; David B. Porter, SAM; Edwin



MEDAL OF THE WALLACE CLARK INTERNATIONAL AWARD RECENTLY CREATED TO HONOR THE MEMORY OF THE LATE WALLACE CLARK, FELLOW ASME

O. Griffenhagen, ACME; and Mr. Maynard, NMC, paid personal tributes to the work of Wallace Clark in the field of international scientific management.

E. Hans Mahler, president of the Swiss Management Council, speaking as a countryman of Dr. de Haan, said that his country was honored to have a Swiss as the first recipient of the award, and that Europe needed more knowledge on how to govern and to manage. Referring to scientific management as an attitude of mind, he said that the whole world stood to benefit from an international exchange of experience on how to organize human effort.

Lillian M. Gilbreth, Fellow ASME, spoke briefly on the background of the award and on the career of Dr. de Haan.

The award, consisting of a medal and a certificate, was presented to Dr. de Haan by John A. Willard, Mem. ACME, and chairman of the Wallace Clark Award Policy Committee. In his acceptance speech Dr. de Haan paid a personal tribute to Wallace Clark. He described the organization and work of the CIOS (Comité International de l'Organisation Scientifique), and discussed European trends in scientific management. The text of Dr. de Haan's talk will be published in a coming issue of MECHANICAL ENGINEERING.

FOWLER McCORMICK, chairman, International Harvester Company, Chicago, Ill., received the 1948 Gantt Memorial Medal "for distinguished achievement in industrial management as a service to the community." The award was presented at a dinner session of the Conference on General Management Problems sponsored by the American Management Association, Waldorf-Astoria Hotel, New York, N. Y., June 8–9, 1949.

Awarded each year since 1929 by the American Management Association and The American Society of Mechanical Engineers to memorialize the achievements of Henry Laurence Gantt, pioneer management engineer, this year's medal carries with it the following citation: ". . .for distinguished leadership of business management in the area of human relations; for understanding and advancement of the concept of business operation in the interest of the consumer, the employee, the investor, and the community; and for unwavering support of democratic principles in industry."

ALLEN HARRY CANDEE, Mem. ASME, mechanical engineer, the Gleason Works, Rochester, N. Y., is the 1949 recipient of the Connell Award, made annually by the American Gear Manufacturers Association. The award is made to Mr. Candee in recognition of his many valuable contributions to the gearing industry's technical knowledge and literature over the past three decades.

SYDNEY CAMM was awarded the British Gold Medal for his outstanding work in the design and development of fighter aircraft. George Edwards received the George Taylor (of Australia) Gold Medal for his paper, "Problems in the Development of a New Aeroplane," which has been widely quoted. These are two of the highest honors which the Council of the Royal Aeronautical Society of Great Britain can bestow.

Safety Awards Announced

THE Joseph A. Holmes Safety Association, which was organized in 1916 to promote safety in the mineral industries, and in which The American Society of Mechanical Engineers is a participant, announced on April 26 that twelve Medals of Honor are being awarded to recognize heroism in saving life after accidents at mines and petroleum installations. The Association also announced the presentation of 188 Certificates of Honor in recognition of outstanding contributions to safety in the mines and plants of the mineral industry. J. F. Barkley, chief, fuels utilization division, U. S. Bureau of Mines, Washington, D. C., is ASME representative on the Association.

People

ARTHUR E. GRUNERT, Mem. ASME and 1941 Melville Medalist, was honored recently by 400 friends and associates at a dinner held at the Palmer House, Chicago, Ill., on the occasion of his retirement as chief operating engineer of the Commonwealth Edison Company, Chicago, Ill., after 40 years of service.

Mr. Grunert started his utility career as a draftsman in 1908 following his graduation from the University of Wisconsin. He held positions of increasing responsibility, and in 1947 became chief operating engineer whose responsibility included operation of four of his company's generating stations with a combined capacity of more than a million and a quarter kilowatts. As member of many ASME Power Test Code committees, Mr. Grunert has contributed to the study of pulverized coal in moving gas stream, definitions and values, and steam turbines. Currently Mr. Grunert is chairman of the boiler water committee of the Utilities Research Commission, and chairman of the joint research committee on steam contamination of the Edison Electric Institute and the Association of Edison Illuminating Companies.

GUSTAV EGLOFF, Mem. ASME, petroleum technologist and director of research of the Universal Oil Products Company, Chicago, Ill., has been elected president of the Western Society of Engineers. Ludwig Skog, Mem. ASME, senior partner, Sargent and Lundy, Chicago, Ill., was elected one of the trustees for three years.

THEODORE F. HATCH, Mem. ASME, has been appointed professor of industrial health engineering of the graduate school of public health, University of Pittsburgh. He will continue part time with the Industrial Hygiene Foundation.

WARD F. DAVIDSON, Mem. ASME, research engineer with the Consolidated Edison Company of New York, Inc., New York, N. Y., delivered the Supply Section Annual Lecture of The Institution of Electrical Engineers in London, England, May 11, 1949. He is the first American to deliver the lecture.

E. G. BAILEY, Fellow and past-president ASME, delivered the 1949 James Clayton Lecture before a meeting of The Institution of Mechanical Engineers in London, England, April 22, 1949. Dr. Bailey received the certificate of honorary membership in the Institution, an honor conferred on him in 1945. Using as his subject, "Invention and the Sifting-Out of Engineering Facts," Dr. Bailey stated that there was a need for greater impetus for inventions in the basic industries if the present standard of living was to be maintained and advanced. He told the British engineers that in the United States, patent rights of employees were usually vested in the employers, but that in his opinion this practice did not cause a holding back of ideas. Greatest opportunities for creative engineering, he said, lay in processing methods, "not only new chemical compounds, but iron, steel, cement, insulating and building materials, refractories, gas from coal, and heat from coal for purposes other than those now considered possible."

SIR HARRY R. RICARDO, Hon. Mem. ASME, was recently named to honorary membership in The Institution of Mechanical Engineers of Great Britain. Sir Harry is technical director of Ricardo and Company, Ltd., Sussex, England.

EUGENE W. SCOTT was appointed recently as the first full-time executive secretary of the Interdepartmental Committee on Scientific Research and Development. Dr. Scott began his new duties on June 1. He was assistant executive secretary of the Research and Development Board of the National Military Establishment. The Committee makes continuing studies of Government programs of scientific research and development, and is charged with recommending steps to make these programs more effective in promoting the national welfare. It studies administrative policies and procedures, including personnel policies, and seeks the advice of industry, universities, and various government agencies in increasing the efficiency of the over-all Federal research program.

WILLIAM REMINGTON BRYANS, Mem. ASME, assistant dean, college of engineering, New York University, New York, N. Y., since 1933, retired in June, 1949, after forty-two years' service. In 1945 he developed a program of humanities and social studies for engineering students. He will become Professor Emeritus at the college and will continue to serve in an advisory capacity on a part-time basis during the academic year 1949–1950.

J. H. SCHAEFER, vice-president, Ethyl Corporation, was elected president of Industrial Research Institute, Inc., at its annual meeting held May 23–25, 1949. The other officers elected were C. F. Rassweiler, vice-president for research and development, Johns-Manville Corporation, vice-president; and Charles G. Worthington, Mem. ASME, who was reappointed secretary-treasurer. Fred Olsen, director of research and development, Olin Industries, Inc., and H. N. Stephens, research director, Minnesota Mining and Manufacturing Company, were elected to three-year terms on the board of directors.

ASME NEWS

Activities of the ASME Executive Committee

At a Meeting at Headquarters, May 24, 1949

A MEETING of the Executive Committee was held in the rooms of the Society, May 24, 1949. There were present: James M. Todd, chairman; T. E. Purcell, vice-chairman; F. S. Blackall, Jr., E. J. Kates, of the Executive Committee; J. H. Lawrence (Finance); W. M. Sheehan, director at large; C. E. Davies, secretary; and Ernest Hartford, executive assistant secretary.

Changes in Rules

Rules governing the Pi Tau Sigma Gold Medal and the Charles Russ Richards Memorial Award were altered to remove the age specification without changing years of service. The action was taken because many men having postponed their education due to their war services, are now graduating at an advanced age. Formerly the Pi Tau Sigma Medal was awarded to men not more than 35 years of age, and the Charles Russ Richards Memorial Award to those not more than 45.

Recipients of 1949 Awards

Upon recommendation of the Board on Honors the following awards were approved:

Phillip S. Myers, assistant professor of mechanical engineering, University of Wisconsin, Madison, Wis., to receive the 1949 Pi Tau Sigma Medal Award.

Arthur M. Wahl, Westinghouse Electric Corporation, East Pittsburgh, Pa., to receive the 1949 Richards Memorial Award.

1950 Charles T. Main Topic

"The Need for Conversion to a Five-Year Course in Engineering Instruction for the Bachelor's Degree in Order to Include Additional Instruction in the Humanities and in Public Relations," was the topic approved for the 1950 Charles T. Main Award.

International Standardization

Upon recommendation of the Board on Codes and Standards, Sectional Committee B1 on Standardization and Unification of Screw Threads and Boiler Code Committee, the following actions were taken:

(1) Approval of the policy statement that ASME participation in the activities of the International Organization of Standardization will be limited to individual projects as approved by the Council.

(2) Authorization of acceptance by the Sectional Committee B1 on Standardization and Unification of Screw Threads of an invitation to be represented at a conference of the ISO which will consider establishment of an international screw-thread system based on unification already achieved by American, British, and Canadian interests.

(3) Authorization of Boiler Code Committee to accept the secretariat of the ISO project on steam boilers and other pressure vessels when such a project is undertaken.

Vote of Appreciation

Thanks and appreciation were voted to members of the committee in charge of the New London Spring Meeting for their hospitality and contribution to success of the meeting.

Certificates of Award

Certificates of award were approved for the following retiring and past-chairmen: *Chicago Section:* Alex D. Bailey, David Lofts, Jay C. Marshall, Burgess H. Jennings, and Robert M. Krause. *Buffalo Section:* Carroll A. Ross and Malcolm N. Brown. *Waterbury Section:* Thomas M. Rianhard, Jr. Certificate of award was also approved for Hamilton H. Mabie, retiring honorary chairman of the Cornell University Student Branch.

Akron-Canton Section

Upon recommendation of Thomas E. Purcell, vice-president, ASME Region V, establishment of the Akron-Alliance-Massillon Subsection of the Akron-Canton Section was authorized.

Roscoe W. Morton

The death of Roscoe W. Morton, ASME manager, 1942–1945, on May 2, 1949, was noted with regret.

PRESIDENT TODD PRESENTS CERTIFICATE OF AWARD TO H. R. KESSLER FOR HIS SERVICES AS CHAIRMAN OF THE METROPOLITAN SECTION FOR TWO YEARS. MR. KESSLER IS THE 1949 SECRETARY OF THE ASME NATIONAL NOMINATING COMMITTEE

Appointments

The following appointments were approved: J. L. Fertig, inauguration of president, Texas Technological College; Edward C. Rightley, inauguration of president, University of New Mexico; A. R. Mumford, commencement exercises, Columbia University; and W. M. Sheehan, as honorary vice-president, South African Institution of Engineers.

Other appointments recommended by the Organization Committee were approved.

Functions of ASME Publications[1]

THE foundation of ASME activity is the creative technical work of ASME members. However, so long as the results remain locked in the mind of their creator or in his files, they contribute nothing to technical progress. Meetings give an opportunity for the presentation of the work of a relatively few members to a small fraction of the engineering profession. They furnish the advantages of personal contacts, a test of worth by the impact of discussion and criticism, and an inspirational value, especially if the presentation is well done. Their shortcomings are due to their transitory nature, and the inability of members even when in attendance at the meeting to be in more than one place at the same time.

Cross-Fertilization

The functions of the Professional Divisions Committee are to stimulate and foster creative professional work of the highest order, and thus to furnish the water of life to all the activities of the Society. The Meetings Committee has the task of promoting cross-fertilization of ideas and of giving opportunities for testing and evaluation, for inspiration, and for interpretation of significance. The functions of the publications of the Society are to enhance the value of the results accom-

[1] Talk given by Hugh L. Dryden, chairman, ASME Publications Committee for 1947–1948, during the 1948 Annual Meeting at a conference sponsored by the Professional Divisions Committee to discuss the subject, "Better Professional Divisions for a Better Society."

plished by the Professional Divisions Committee and the Meetings Committee by extending their availability to all interested members, to record permanently the significant papers so that they are available at any time, and to report and interpret to other specialists and to intelligent citizens the advance of technical progress in the engineering field.

The tremendous increase in the quantity of written matter offered for presentation and publication, the increasing difficulty in appraising the importance of specific manuscripts in an age both of increasing scope of material and intensity of specialization, and the great increase in publication expense have presented difficult problems to the Publications Committee. You are all familiar with the new plan which has now been in effect for one year. It provides a reporting in digest form of all ASME meeting papers, makes many more meeting papers available in pamphlet form, reduces waste and publication expense, and maintains permanent publications of high standard. This plan is to be reviewed early in 1949 by the Publications Committee and your help is solicited in improving its operation still further.

The ASME is unusually fortunate in the excellence of its general-interest publication, Mechanical Engineering, which reflects the outstanding ability of the editorial staff. Its feature articles, its reports of technical progress in Briefing the Record, its editorials, and its digests of ASME papers received well-merited praise in the reader-interest survey conducted by the Publications Committee during the past year.

The new publication, *Applied Mechanics Reviews*, which began publication last year with the co-operation of The Engineering Foundation and the Office of Naval Research, is making an important contribution to the advance of research in applied mechanics and is bringing new laurels to the Society as the leader in this field.

Appraisal of Papers

The Publications Committee has given some and will give further consideration to methods of appraising the significance of papers and of selecting papers for permanent record. In this the assistance of specialists in each field is essential, since no one person can have sufficient knowledge nowadays to weigh the intrinsic value of specialized papers. Along with this intrinsic value must be weighed the value to the whole profession. The Committee believes that there is no substitute for informed professional opinion in the rating of papers. Here the Professional Divisions Committee can make a large contribution.

I would like to express my own personal appreciation as an ASME member for having had the opportunity of serving on the Publications Committee, thus becoming acquainted with the difficulty of the problems and the need for co-operation of members in solving them. Each member of the ASME can help by clear presentation of his best work in ASME papers, by early submission of manuscripts in time for preprinting, and by prompt review of papers when requested by the Professional Divisions Committee.

So You Want to Increase Your Membership!

The question, "How did you do it?" has been asked of the ASME University of Nebraska Student Branch so many times that its executive committee decided to put its "secrets" in writing. We hope that some of our methods will be of value to other ASME student branches and other organizations.

Immediately following the election of officers for the fall semester of 1948, plans were laid for their term. A publicity chairman was selected and given a tentative plan of action. An entertainment chairman for the first meeting was selected and informed that a *big* opening session was to be carefully planned.

Several conferences were held during the summer with the entertainment chairman and plans were laid for a gala opening night. The importance of this early groundwork cannot be overestimated, and it is noteworthy that the successful first meeting probably did more to boost the membership than any other single factor.

Goal Is Set

It was decided to set the goal at a membership of 200 in the first semester. This number was considered too high by some since the membership at the end of the previous year was only 161, yet the student enrollment from which to draw was approximately the same.

The entertainment for the opening meeting was to be of top quality to serve as a foretaste of the kind of sessions we expected to conduct throughout the year. To meet this high standard the "Keymasters," a local barbershop quartet, were hired for 20 minutes of good singing. Their offering was a great success, as was the performance of H. Westgate, "The Wizard," with his magic show. Mr. Westgate is a member of the mechanical-engineering faculty. To climax the evening, refreshments of cokes and brownies were served. The cokes were cold and the brownies were good. Cigarettes (sample packs of four) were distributed as compliments of one of the tobacco companies. Matches were also given by a local concern. Ash trays were provided by the sales manager of an interested Omaha concern.

To insure a large attendance at the first meeting there were other events which took place through the summer months. A list of possible programs was drawn up so that something definite could be promised the men. A meeting with the faculty adviser was arranged and plans for the semester were discussed and new ideas brought out. The suggestion was made that the privilege of smoking during the meetings would materially encourage attendance, and this was discussed with the department chairman who in turn obtained permission to allow smoking. Heretofore smoking was not allowed on any occasion; thus the new privilege was a strong drawing card.

From the first day of school the executive committee and other interested students "talked ASME," the plan being to expose every mechanical engineer to the letters, "ASME." The publicity committee sent out postcards to every eligible student telling him

The Secret

When an ASME student branch enrolls 93 per cent of a potential membership of 272 there must be something uncanny about the powers of the local leadership. So amazing was the record enrollment of the University of Nebraska student branch last semester, that Society officers asked for the "secret" of its success so this could be shared not only with other student branches, but with junior groups and Sections where organizational problems have so much in common. Here it is, in apple-pie order, for all to use, as reported by the University of Nebraska student branch executive committee composed of: W. D. Birdsall, chairman; J. L. Wilkins, vice-chairman; H. G. Bienhoff, secretary; and R. J. Hazelrigg, treasurer.

about the first meeting, emphasizing the program, and announcing the lift of the no-smoking rule. Signs were placed on the bulletin boards of the engineering buildings and notices were put on the blackboards in the mechanical-engineering classrooms. It was found important that signs be up at least three days before meetings and that there should also be a sign on the regular bulletin board a week in advance to allow students to make long-range plans. Further to publicize the first meeting, instructors were asked to make announcements to their classes and urge everyone to attend. An article also was published in the student daily paper.

The meeting was called at 7:15 p.m. and that hour saw men bringing in extra chairs to supplement the 157 seats of Room 206, Richards Laboratory. A group of about 180 were present to be greeted by the honorary chairman who outlined the advantages of ASME to the students; the department chairman who also emphasized values to be gained by membership; and the student chairman who first pointed out the excellent magazine available to members, then outlined the semester's activities, and gave assurance that no training films would be used for programs; also that every meeting would be interesting and worth while. (Previous years show that this easy means of supplying entertainment served to decrease attendance materially.) The general attitude of those who spoke was that we expected everyone present to join. We profited by the oversight of preceding groups in having receipt books made out beforehand, so that it was only necessary to write a name on the receipt as the student turned in his application form and his $3 fee.

Application Forms Ready

The application forms were handed to every man before he entered the room so that these

could be filled out during the course of the meeting. Instead of one person to take the forms and give out receipts there were ten. No applicant had to wait more than a few minutes to sign up. One oversight was our failure to have check blanks available. The meeting netted us 161 members.

For three days of the following week the membership committee had a table in the hall of the Mechanical Engineering Building with a large sign announcing that those who had not become members could still do so. Here the membership was raised to 225, which was 25 above our original goal. By the time the booth was installed word had spread that "everyone joins the ASME," so that the enrollment snowballed to this new high. When the table was removed the membership-card file was checked against the department files and each student not yet a member was contacted personally by someone on the committee, thus swelling the total to the unprecedented number of 251 out of approximately 270, or 93 per cent of the upperclassmen.

Co-operation and planning have been the keynote throughout the campaign. No one person has tried to take credit for the project—it is always "we" not "I." The men chosen to work on the committees were all hard workers interested in the organization. These men were selected from all interests and so-called "cliques" in the college; thus no one could complain that a certain small group was controlling the organization. No executive committee should overlook the valuable aid that it can receive by frequent conversations with other members about the problems at hand. We received many ideas in this way.

Without the co-operation, advice, and backing of an interested and energetic faculty adviser the operation of a successful branch would be extremely difficult.

ASME Calendar

of Coming Events

Sept. 12–16
ASME Industrial Instruments and Regulators Division Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.
(Final date for submitting papers was May 1, 1949)

Sept. 27
ASME Wood Industries Division Conference, Jamestown, N. Y.
(Final date for submitting papers was May 1, 1949)

Sept. 28–30
ASME Fall Meeting, Erie, Pa.
(Final date for submitting papers was May 1, 1949)

Oct. 2–5
ASME Petroleum Division Conference, Oklahoma Biltmore Hotel, Oklahoma City, Okla.
(Final date for submitting papers was June 1, 1949)

Oct. 26–27
ASME Fuels Division Conference, French Lick Springs Hotel, French Lick Springs, Ind.
(Final date for submitting papers was June 1, 1949)

Nov. 27–Dec. 2
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(Final date for submitting papers—Aug. 1, 1949)

April 10–14, 1950
ASME Spring Meeting, Hotel Statler, Washington, D. C.
(Final date for submitting papers—Dec. 1, 1949)

June 19–23
ASME Semi-Annual Meeting, Hotel Statler, St. Louis, Mo.
(Final date for submitting papers—Feb. 1, 1950)

(For Meetings of Other Societies See Page 623)

ASME Publicity

THE American newspaper and periodical press are following more closely than ever before what is being done and said at the annual meetings of The American Society of Mechanical Engineers, according to George A. Hastings, ASME public-relations director.

Although the 1948 Annual Meeting lacked some of the dramatic and popular-interest material which can usually be counted upon to make good publicity copy, more than 614 editorials and newspaper and periodical stories have been clipped from papers appearing in the press of 36 states and the District of Columbia, and clippings are still being received. ASME news stories were on the wires of the Associated and United Press. New York papers alone carried over 57 separate stories.

These results reflect the growing recognition by the press of the importance and prestige of the Society.

As a service to the press, the ASME publicity staff prepared 41 releases covering high lights of papers and events on the program. In addition to mailing advance releases, many press contacts were made by telephone to call attention to interesting features of the program. During the meeting the ASME pressroom was used by the 40 editors, reporters, and special writers who commented favorably on the quality of service rendered.

Plans for Fall Meeting Taking Shape

TWENTY ONE technical sessions have already been scheduled for the Fall Meeting of The American Society of Mechanical Engineers to be held in Erie, Pa., Sept. 28–30, 1949. Under the chairmanship of George W. Bach, president, American Sterilizing Company, Erie, Pa., the ASME Erie Section, hosts at the meeting, are making arrangements for a round of social events to complete the program.

Technical sessions will be sponsored by the following Committees and Professional Divisions: Management; Power; Heat Transfer; Production Engineering; Metals Engineering; Machine Design; Fuels; Process Industries; Aviation; Gas Turbine Power; Industrial Instruments and Regulators; Materials Handling; Petroleum; Railroad; Rubber and Plastics; Education; and Engineers Civic Responsibility.

East Tennessee Section Holds Spring Meeting

THE annual spring meeting of the East Tennessee Section of The American Society of Mechanical Engineers was held at Kingsport, Tenn., on May 20, 1949. There were afternoon and evening sessions, plant visits, speakers, and a dinner. The plants visited by various groups include the Kingsport Press, Mead Corporation, Blue Ridge Glass Corporation, and Tennessee Eastman Corporation.

There were two speakers, F. R. Conklin, assistant works manager of Tennessee Eastman Corporation, whose subject was the "Engineer in Industry." In his talk he told of the challenges, opportunities, contributions, responsibilities, and rewards which lie in store for the engineer in industry. He spoke about the two aspects of the art of engineering: the feel or professional touch that comes after long experience and the new and yet old art of human engineering—the art of getting along with people.

R. M. Boarts, head of chemical engineering at the University of Tennessee developed the theme "Partnership of the Engineering School With Industry" emphasizing particularly that the universities and industry have grown from common roots in American life and their aims are comparable. He strongly advocated better relations between both to overcome recent adverse publicity which is creating confusion.

ASME Sections

Coming Meetings

Southern California: July 6. Professional Division, 601 West 5th St., Los Angeles. Subject: 1950 Section Activities, by J. S. Earhart.

July 6. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Water Works Systems, by R. E. Hemborg.

July 13. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Design and Application of Propeller Pumps, by D. R. Rankin.

July 20. Applied Mechanics, Instruments and Regulators Divisions, 601 West 5th St., Los Angeles. Subject: Interpreting Dynamic Instruments, by Dr. M. A. Greenfield.

July 20. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Piping Codes and Standards, by H. Meyers.

July 27. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Pneumatic Circuit, by J. L. Dooley.

Section Activities

REPORTS of the following ASME Section Meetings were received recently at Headquarters:

Baltimore, May 23. Speakers: A. Hart and T. Sullivan. Subject: Economic and Engineering Aspects of Airport Development. Attendance: 80.

Chattanooga, May 13. Speaker: J. R. Kruse. Subject: American and European Marine Boilers. Attendance: 92.

Kansas City, May 9. Ladies' night meeting. Speaker: Prof. E. C. Buehler. Subject: Are You as Good as You Sound? Attendance: 132.

Milwaukee, May 11. Ladies' night meeting. Speaker: H. L. Orians. Subject: Wildlife on Lake Michigan and Its Surroundings, illustrated with colored film. Attendance: 70.

New Orleans, May 12. Speaker: R. M. Seago. Subject: Heat Engineering. This meeting was one in a series of streamlined technical sessions. Attendance: 46.

Oregon, May 23. Speaker: P. E. Sullivan. Subject: Centrifugal Pumps. Attendance: 17.

Piedmont, May 19. Election of new officers. Speakers: J. M. Todd, president ASME and A. Roberts, Jr., vice-president, ASME Region IV. Subjects: Duties and Privileges of the Engineer of Today and his Role in Future Development; The Individual Member's Part in the Affairs of the National Organization.

Philadelphia, May 23. Annual outing at the Whitemarsh Valley Country Club. Attendance: 330.

Raleigh, May 13. Speaker: H. L. Mosher. Attendance: 45.

Rocky Mountain, May 13. Ladies' night meeting. Films: "The Chicago Railroad Fair," and "Scenery Unlimited." Introductory remarks by J. H. Whipple. Attendance: 33.

Southern California, May 4. Hydraulic Division. Speaker: R. E. Hemborg. Subject: Valve Location and Installation. Attendance: 42.

May 4. Management Division. Speaker: E. Favary. Subject: Systematization. Attendance: 81.

May 4. Professional Division. Speaker: J. S. Earhart. Subject: 1950 Section Activities. Attendance: 12.

May 6. Field trip to U. S. Spring and Bumper Co. Attendance: 110.

May 11. Gas Turbine and Heat Transfer Divisions. Speaker: C. M. Wolfe. Subject: Temperature Measurement of Jet Engine Gases. Attendance: 65.

May 11. Photographic Division. Speaker: A. L. Ground. Subject: Template Reproduction. Attendance: 88.

May 11. Hydraulic Division. Speaker: P. Brown. Subject: Pump Theory and Practice. Attendance: 38.

May 18. Instruments and Regulators Division. Speaker: J. C. Graenewegen. Subject: Instruments and Controls. Attendance: 92.

May 18. General Meeting. Speaker: V. A. Peterson. Subject: Diesel Engine Turbo-superchargers. Attendance: 52.

May 18. Hydraulic Division. Speakers: W. O. Wagner and P. Kyropoulos. Subject: Piping Theory and Design. Attendance: 44.

May 25. Applied Mechanics Division. Speaker: J. Miles. Subject: Dynamic Stability. Attendance: 69.

May 25. Hydraulic Division. Speaker: J. L. Dooley. Subject: Pneumatic Systems. Attendance: 32.

May 25. Management Division. Speaker: E. Favary. Subject: Leadership. Attendance: 102.

May 27. General Meeting. Speaker: N. Wiener. Subject: Cybernetics. Attendance: 1662.

May 30. Field trip to Palomar Mountain. Attendance: 55.

South Texas, Junior Group, May 12. Dinner meeting, to introduce H. H. Urech, new chairman of the group, and F. G. Muller, vice-chairman. Attendance: 15.

Tri-Cities, April 26. Joint meeting with State University of Iowa student branch. Three student papers presented: (1) Water Alcohol Injection for Gas Engines, by E. Brown; (2) The Oxy-Arc Cutting Process, by P. Chalupsky; (3) Dimensional Analysis Applied to a Centrifugal Pump, by W. Talbert. Section award of $10 for the best presentation was made to Mr. Talbert. Attendance: 60.

May 24. Plant inspection trip to the Dewey Portland Cement Company's plant, Davenport, Iowa, with dinner at Riverside Inn. Speaker: E. S. Ernst. Subject: Manufacture of Cement. Attendance: 42.

Virginia, May 13 and 14. Annual joint meeting with Virginia engineers. Technical sessions, dinner and dance, and program for the women. Tour of The Mariners Museum and Hydraulics Laboratory of Newport News Shipbuilding and Dry Dock Company. Attendance: 150.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which operates in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

INDUSTRIAL ENGINEER, BSME, graduating MS in IE June. Seeks employment of diversified nature with progressive organization; familiar with systems and cost control. Chicago area. Me-433.

MECHANICAL ENGINEER, 29, single, BSME; five years' power-plant experience; licensed marine chief engineer, desires placement in plant operation, development, or construction. Will locate anywhere; working knowledge of Spanish. Available immediately. Me-434.

MECHANICAL ENGINEER, 26, married, master's degree. Air Corps engineering officer. Six years' experience on engines, lubrication, heat transfer, steel-mill equipment. Capable assistant for busy executive. Me-435.

MECHANICAL ENGINEER, 23, married, 1948 graduate, seeks position with medium or small-size business offering interesting work. Will travel anywhere, including abroad. Will also consider instructor's position with opportunity for taking master's. Me-436.

INDUSTRIAL UTILITIES, MAINTENANCE SUPERINTENDENT, mechanical engineer, 39, outstanding supervisory record in cost reductions by application of technical understanding and preventive management. Comprehensive industrial power, utilities, and maintenance experience. Me-437.

CHIEF ENGINEER, ME, Stevens, 1937. Unusual precision metalworking background combining administration, product development, manufacturing methods, tooling, and time study. Capable assuming full engineering responsibility from design through production. Me-438.

MECHANICAL ENGINEER, 40, graduate Purdue. Ten years' experience with manufacturer of small precision instruments, in charge of process planning, special tooling, and development of new products. Northwestern Pennsylvania. Me-439.

MECHANICAL ENGINEER, 24, single, Brown University, recent graduate, BSME. Heat

[1] All men listed hold some form of ASME membership.

and power specialty, training program desired. Will travel or relocate. Me-440.

MECHANICAL ENGINEER, 23, single, BSME, one year's experience as production engineer, working on plant layouts, production control, scheduling, and estimating. One year's experience in piping design drafting on refineries and chemical processes. Desires contact with firm seeking reliable, ambitious engineer. New England area. Me-441.

MECHANICAL ENGINEER, 25, single, BSME. Army veteran, graduating June, 1949. Likes to write. Prefers engineering employment on East or West Coast, but will go anywhere. Me-442.

PLANT ENGINEER, BME, 33, married, registered N. Y. State. Experience: maintenance and construction supervision, plant layout and services, stress calculations, steam and power generation, specifications, costs. Former Seabee officer. Location immaterial. Me-443.

MECHANICAL ENGINEER, 38, married, registered PE, desires position as either plant manager of small plant or plant engineer. Experienced in production and maintenance and sales in mining, nonmetallic and metallic, machinery manufacturing, hydraulics, and paper and pulp mills. Southern area. Me-444.

MECHANICAL ENGINEER, 37, married. British University Honors degree, 11 years' experience. Design, development, management, sales. Medium-size manufacturer: blowers, process vessels, conveyers, furnaces, structures, castings. Electrical background. Writing ability. East or Midwest. Me-445.

DESIGN ENGINEER, 30, BSME. Five years' varied experience on engines, transmissions, valves, and general machine work. Ability to perform complete design and carry projects to completion. East Coast. Me-446.

MECHANICAL ENGINEER, University of Delaware, recent graduate; desires position in maintenance, service, or operation. Me-447.

JUNIOR INDUSTRIAL ENGINEER, BSME, Rutgers University; one year's experience; 27, married, willing to relocate. Opportunity first consideration. Me-448.

CHIEF INDUSTRIAL ENGINEER, PLANT MANAGER, OR ASSISTANT TO TOP MANAGEMENT. Licensed PE. Wide experience in welding research; product design and development; routine production; supervision and inspection; training and plant layouts. Objectives: quality products produced by day or piecework at lowest possible cost. Me-449.

MECHANICAL ENGINEER, BS, MME, expects professional license New York State in September. Four years' heavy experience industrial power plants; design, testing, and operation. Me-450.

RESIDENT ENGINEER - PLANT ENGINEER, 45; twenty years' experience supervisory, power plants, building, factory operation, and maintenance. Assume full responsibility engineering functions. Some design. Degree. Me-451.

MECHANICAL ENGINEER, 27, recent graduate; veteran; six years' railroad experience as mechanic and foreman on steam, electric, and Diesel locomotives. Versatile in machine shop. Desires railroad or power work, or training program. Me-452.

MECHANICAL ENGINEER, 25, BME plus one and a half years toward a BBA. Proved executive and administrative ability. M/Sgt. Army; Administrative Non-Com. Manager overseas post exchange. Originated, planned, and managed an undergraduate book exchange $13,000 volume in three weeks. Me-453.

MECHANICAL ENGINEER, 28, married, BSME, PE license. Eight years' diversified experience in tool and special automatic machine design and development. Eastern U. S. or Los Angeles, Calif., area. Me-454.

RECENT MECHANICAL ENGINEERING GRADUATE, BSME, 25, married. Desires position affording opportunity for advancement in any phase of engineering: sales, development, or industrial preferred. Three years' business experience. Will travel. Me-455.

MECHANICAL ENGINEER, 23, married, BME. Three years' teaching experience in drafting and design. Additional office procedure and selling experience. Desires sales engineering or design. Northeastern area. Me-456.

RECENT GRADUATE, 27, BME, top fourth of class, desires work with development or production engineer in automotive field. Five years' shop experience: assembly, installation, supervision of small groups. Married, veteran. Me-457.

INDUSTRIAL ENGINEER, 25, Columbia graduate, June, 1949. Former naval officer. Good school record, active in extracurricular organizations, parttime employment. Desires position where hard work and initiative will lead to good future. Me-458.

RECENT GRADUATE, 27, BME, top quarter of class, married; some experience in heating and sales. Consider any position with good future. Will go anywhere in U. S. A. Me-459.

MECHANICAL ENGINEER, 44, single, languages, desires technical job or foreign sales. Some experience in production, power plant, teaching. Me-460.

MECHANICAL ENGINEER, June graduate, Cooper Union. High scholastic rating. Navy electronics experience. Some knowledge of automatic-control instruments. Will locate anywhere. Me-461.

MECHANICAL ENGINEER, four years' diversified production and design experience. Now assistant to production manager. Capable project co-ordination, trouble shooting. Accustomed to tough jobs. Me-462.

RECENT GRADUATE, 28, Cooper Union, single, ambitious, desires position anywhere in U. S. in power generation, engine, or turbine development. Top student with best references. Some machine-design experience. Me-463.

ENGINEER, 28, recent graduate, Syracuse University, BME, family. Desires position with future in design and development or research. Rocket research preferred. Prefer to locate outside New York area. Me-464.

POSITIONS AVAILABLE

PLANT-BETTERMENT RESULTS ENGINEER, mechanical graduate, American university, 40–45, with eight to ten years' experience in the operation and maintenance of steam-electric stations. Some knowledge of boiler operation and control, boiler-water treatment, plant instrument and condensing-turbine generator units. Headquarters, New York, N. Y., with considerable traveling; four to eight months in Central and South Americas. Y-2364.

CONSTRUCTION ENGINEER, mechanical or civil graduate, 28–35, with petroleum terminal experience, to supervise waterfront construction, tank erection, draw up contracts, sublet work, etc. Married man preferred with knowledge of Portuguese. $7000–$8000. Brazil. Y-2419.

SALES ENGINEER, mechanical graduate, experience in the sale and application of centrifugal pumps. Considerable hydraulic experience necessary. $4200–$4800, plus bonus. New England territory. Headquarters, Boston, Mass. Y-2433.

CHIEF INDUSTRIAL ENGINEER, 35–40, engineering graduate, with at least five years' experience as chief industrial engineer or assistant of company in varied fields, including process operations, to take charge of industrial-engineering division. $10,000–$12,000, plus bonus. Foreign. Y-2444.

CHIEF ENGINEER, mechanical, over 40, to undertake the complete reorganization and continue in charge of the engineering department of small company manufacturing patented mechanical remote control used extensively in the aircraft, automotive, farm implement, and marine industries. $8000–$12,000, depending on qualifications. Pennsylvania. Y-2447.

MAINTENANCE AND CONSTRUCTION SUPERVISOR, 45–50, mechanical graduate, with at least ten years' institutional or hotel experience, to schedule preventive maintenance, attend to subcontracting of building repairs, plan improvements, etc. $5000–$6000. New York, N. Y. Y-2455.

PLANT SUPERINTENDENT, 35–50, for company manufacturing steam generators. $10,000–$12,000. Illinois. Y-2516C.

INDUSTRIAL ENGINEER, 30–45, graduate IE, EE, or ME, with experience in the metal industry or in the management consultant line, including preparation of organizational charts, reviewing department duties and responsibilities, and preparing concise definitions; preparing job breakdown for department manuals for clerical and supervisory positions; preparation of flow charts, recommend improvements in procedures for increased efficiency, and experience in setting office standards desirable. Salary open, commensurate with qualifications. Connecticut. Y-2517.

ASSISTANT TO SUPERINTENDENT OF MANUFACTURING, preferably young, mechanical graduate, with some experience in general manufacturing, plant equipment, building equipment, power plant and services, materials-handling equipment, printing machinery, and machine shop. Will assist in selecting, installing, and supervising above; and prepare to assume duties at higher level for large manufacturer of food, toiletry, cosmetics, medicines, farm feeds, veterinary products. Some traveling to other plants. $3600–$4200, plus incentive bonus for young man, and higher for man with greater experience. North central state. R-5698.

RECENT GRADUATES, mechanical and chemical engineers, graduates, for print-shop training. Will enter as skilled tradesman training with opportunity for advancement to shop supervisory, superintendency, and plant administrative positions for a leading printing and publishing company. Salary to start, $3276. Illinois. R-5708.

(*ASME News continued on page 632*)

PROJECT DESIGN ENGINEER, 30-40, mechanical graduate, with five years' experience with kitchen exhaust fans. Knowledge of household or oscillating fans acceptable. Will build and develop, improve line, and will design new lines of kitchen exhaust fans for a manufacturer. Salary open. Midwest. R-5712.

CHIEF ENGINEER, thoroughly familiar with combustion engineering, able to apply knowledge and experience to large variety of installations. Good knowledge of fan performance and operation. Will individually engineer and design industrial gas-burning equipment applied to a wide variety of industrial processes, largely connected with firing paint-drying ovens, dry-off ovens, and other equipment requiring temperatures of 300 F to 1400 F. Salary open. Illinois. R-5715.

DESIGN ENGINEERS. (*a*) Design engineer, mechanical graduate, with ten years' experience in heat-power engineering, design, and supervision of design of large air compressor, heat exchangers, refrigeration, and air drying systems. $6000-$7200. (*b*) Design engineer, mechanical graduate, with five years' experience; working knowledge of thermodynamics, design of large air compressors, heat exchangers, refrigeration, and air drying systems. $4800-$6000. Missouri. R-5719.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after July 25, 1949, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

Adams, R. B., Lebanon, Ind.
Albertson, J. Mark, La Grange, Ill.
Allcock, A. J., Jr., Inglewood, Calif.
Allen, Kenneth Robert, Brooklyn, N. Y.
Baker, L., Liverpool, England
Barden, Richard H., Chicago, Ill.
Barefoot, Owen Rupert, Toronto, Ont., Can.
Barland, Lauri C., West Chester, Pa.
Beach, Philip T., Youngstown, Ohio
Bennet, Robert H., New Canaan, Conn.
Blood, Harold Langley, Worcester, Mass. (Rt)
Boyd, Ford E., Duluth, Minn. (Rt)
Boyle, Edward S., Quakertown, Pa.
Brooks, Carl D., Sterlington, La.
Brown, Charles Albert, Pawtucket, R. I.
Cavanaugh, Edward J., Santa Clara, Calif.
Cisco, Edward Samuel, Hammond, Ind.
Cohen, Jack Howard, Indianapolis, Ind.
Cole, Fred Howard, Culver City, Calif.
Curlee, Thomas O., Jr., Greenville, S. C.
Damm, John A., Hoboken, N. J.
Drake, Edward P., Glendale, Calif.
Ducey, John F., Jr., New York, N. Y.
Du Plessis, S. C. M., GPO Annexe, Pretoria, S.A.
Dynes, Wesley M., Los Angeles, Calif.
Eccles, William, Somerset, England
Eisenberg, Phillip, Washington, D. C.
Englund, James S., Pullman, Wash.
Fentress, David Wendell, Elgin, Ill.
Fleck, John A., Chicago, Ill.
Folsom, Deane R., Springvale, Me.
Gallentine, Donal Ogden, Gainesville, Fla.
Gentzel, P. H., State College, Pa. (Rt)
Gerrity, Edward James, Chicago, Ill.
Goldston, Robert Lamonte, Kannapolis, N. C.
Grabowski, Hilary A., Chattanooga, Tenn.
GunduRao, Chitaldurg Bhimarao, Apollo Bunder, Bombay, India
Harker, Ralph Jackson, Madison, Wis.
Hattaway, J. D., Kingsport, Tenn.
Healy, John Donald, Shaker Heights, Ohio
Hilding, W. E., Storrs, Conn.
Horn, John M., York, Pa.
Hughes, Thomas C., San Diego, Calif.
Humphreys, Robert L., Baltimore, Md.
Johnson, C. E., Atlanta, Ga.
Johnson, Herbert F., Worcester, Mass. (Rt & T)
Kearns, Richard B., St. Louis, Mo.
Kegarise, Ralph R., Winston-Salem, N. C.
Keith, John A., Inglewood, Calif.
Knox, E. S., Glendale, Calif.
Krenz, Walter R., San Francisco, Calif.
Magarigal, Roy P., Philadelphia, Pa.
Marlow, F. W., St. Louis, Mo. (Rt)
Marsden, Ernest B., Erie, Pa.
Marshall, Albert W., Dravosburg, Pa.
Matthews, W. C., Santa Maria, Calif.
Mayhoffer, John D., Louisville, Colo.
Mazarakis, Arthur G., Hubbard, Ohio
McCabe, Edith B. (Mrs.), Chattanooga, Tenn.
McDaniel, Benjamin Harrison, Jr., Atlanta, Ga.
McGowan, Francis R., Youngstown, Ohio
Miller, Edwin W., New York, N. Y.
Mines, Chester Eugene, Indianapolis, Ind.
Muni, Harry W., Oneonta, N. Y.
Murray, Archie Vernon, Pittsburgh, Pa.
Nanavaty, Ambalal Hiralal, Philadelphia, Pa.
Nelson, Francis S., Kansas City, Mo.
Novick, Walter C., Philadelphia, Pa.
O'Donnell, James Francis, Maumee, Ohio
O'Keefe, Francis F., Winston-Salem, N. C.
Olmstead, Harry L., Fair Lawn, N. J.
Parks, William W., Oak Park, Ill.
Pierson, Theodore A., 3rd, Bound Brook, N. J.
Pinkel, Benjamin, Cleveland, Ohio
Porson, Allan B., New York, N. Y.
Powell, Joe R., Charlotte, N. C.
Renner, Robert R., Boston, Mass.
Richards, Clifford James, Houston, Texas
Rodder, William, Poland, Ohio
Roethe, Lester A., Jr., Stony Creek Mills, Pa.
Rutherford, John J. B., Beaver Falls, Pa.
Schakel, Raymond A., Indianapolis, Ind.
Schlintz, Harold H., Lafayette, Calif.
Schoenbaum, William Joseph, Los Angeles, Calif.
Seifert, Richard W., Kirkwood, Mo. (Rt & T)
Seiler, A., Philadelphia, Pa.
Shannon, Jean Russell, Clintonville, Wis. (Rt)
Shreeve, Robert E., Baltimore, Md.
Smith, Goff, New York, N. Y.
Smith, Howard B., Jr., Dumont, N. J.
Snyder, Perry G., Youngstown, Ohio
Sooy, Brainard Earl, Middleton, Ohio
Sorg, Henry L., Glenside, Pa. (Rt & T)
Speckmann, Robert E., E. Chicago, Ind.
Starr, D. Keith, Santa Monica, Calif.
Stevenson, Harry W., Jr., Cincinnati, Ohio
Sutherland, Robert L., Iowa City, Iowa (Rt & T)
Tagg, Jerome, Denver, Colo.
Thayer, Byron C., Tulsa, Okla.
Thomas, Vincent P., New York, N. Y. (Rt & T)
Underwood, Claud W., Premont, Texas
Veith, Charles J., Wilmington, Del. (Rt & T)
Wanderer, Donald W., Oak Park, Ill.
Ware, Thomas M., Chicago, Ill.
Wernecke, Heinz Carl, Saginaw, Mich.
Wiggin, Blanton, Needham, Mass.
Wisner, William Roy, Pawtucket, R. I.
Wittman, David, Buffalo, N. Y.
Wolfe, George Edward, Plainfield, N. J.

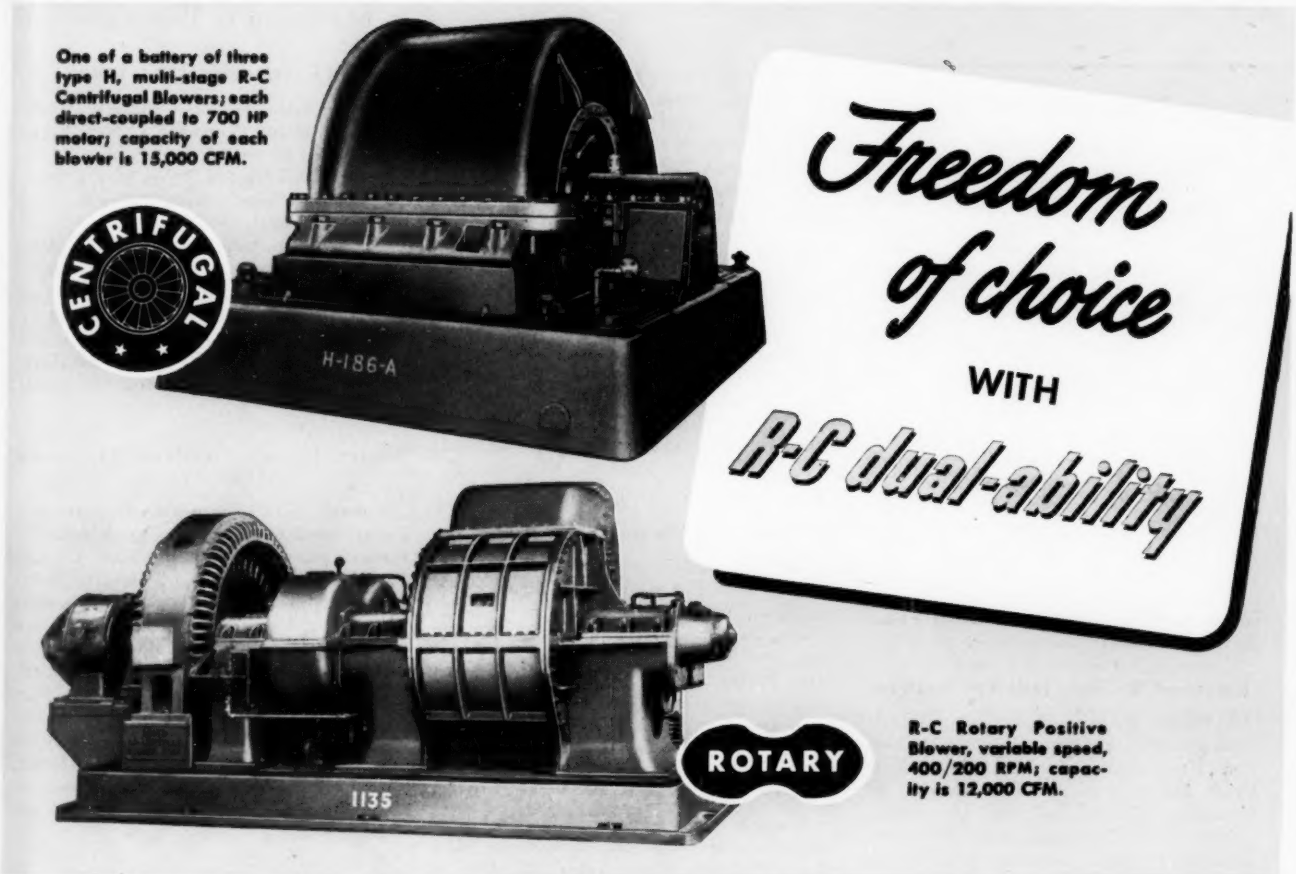
CHANGE IN GRADING

Transfer to Member

Buntin, R. W., Devon, Pa.
Caserza, Louis M., Colma, Calif.
Cloutier, Jean Paul, St. Constant Cte. de la Prairie, Que., Can.
Dommers, Walter Alexander, Wallingford, Conn.
Drucker, Daniel C., Providence, R. I.
Fischer, Udo W., Glenside, Pa.
Hugo, Selwyn W., Crewe, Cheshire, England
Jenkins, Donald R., Los Angeles, Calif.
Jewett, Frank Baldwin, Jr., Minneapolis, Minn.
Judd, Marcus A., Wood, Milwaukee, Wis.
Kalvelage, Francis J., Jr., Detroit, Mich.
Ketchum, Kenneth Woodrow, Rio de Janeiro, Brazil
Koch, Peter, Seattle, Wash.
LeConey, H. M., Jr., Richmond, Va.
Lomax, Burt, Jr., Jackson, Miss.
McKeand, M. L., Dayton, Ohio
McLaughlin, W. G., St. Catharine's, Ont., Can.
Medlin, John W., Lake Jackson, Texas
Meyer, L. W., Schylkill County, Cressona, Pa
Murphy, E. Landry, New Orleans, La.
Osborne, Bodwell Doe, Asheville, N. C.
Ravese, Thomas, Port Chester, N. Y.
Sutton, Frank Maynard, Lawrence, Kan.
Weisbein, Jack, Kansas City, Mo.
White, V. M., Ridgewood, N. J.

Transfers from Student Member to Junior 800

(*ASME News continued on page 634*)



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Obituaries

James Hervey Simpson Bates (1863–1949)

JAMES H. S. BATES, consulting engineer, died of diabetes in a nursing home in Tacoma, Wash., on March 10, 1949. Born, Cincinnati, Ohio, Aug. 28, 1863. Education, ME, Stevens Institute of Technology, 1887. Mem. ASME, 1914.

Orville Woodrow Chandler (1918–1949)

ORVILLE WOODROW CHANDLER, head of turret section, Aeronautics and Ordnance Systems Divisions, General Electric Co., Schenectady, N. Y., died at the Ellis Hospital, Schenectady, N. Y., Feb. 19, 1949. Born, Louisville, Ky., July 1, 1918. Parents, Orville Barnes and Egbertha Chandler. Education, BSME, University of Texas, 1941. Married Elinor R. Sigler, 1945. Jun. ASME, 1942. Survived by his wife and father.

Raymond William Dull (1874–1948)

RAYMOND WILLIAM DULL, owner of consulting engineering firm, died July 19, 1948. Born, Newark, Ohio, April 29, 1874. Parents, Uriah and Orlinda Dull. Education, BS, University of Illinois, 1897; ME, University of Illinois, 1910. Married Edna M. Pope, 1901; children, Florence, Clermont, and Richard. Mem. ASME, 1908.

Arthur Edward Johnson (1856–1949)

ARTHUR EDWARD JOHNSON, retired ordnance and ballistics expert, designer of disappearing heavy gun carriages, with the War Department, Washington, D. C., died in Cleveland, Ohio, April 23, 1949. Born, Brookfield, Mass., March 8, 1856. Parents, William Moore and Elizabeth (Merritt) Johnson. Education, public schools. Married Jennie Francis Rand, 1880; children, Arthur Edward (deceased), Chester Richard, and Reginald Rand. Married 2nd, Mary Gertrude Wright, 1896; children, Mary Asenath and William Moore. Jun. ASME, 1890; Mem. ASME, 1892.

Jere Grant Kingsbury (1865–1944)

J. GRANT KINGSBURY, former president of The Grant Manufacturing and Machine Co., Bridgeport, Conn., died in California on March 24, 1944. Born, Towanda, Pa., March 20, 1865. Parents, Adolph Henry and Sarah Adeline (Brown) Kingsbury. Education, graduate, ICS. Married Alice Edith Foote, 1889. Married 2nd, Ruby Irene Stults, 1931. Mem. ASME, 1906.

Roscoe William Morton (1900–1949)

ROSCOE W. MORTON, professor and head, department of mechanical engineering, University of Tennessee, died of a heart attack on May 2, 1949, at a hospital in Knoxville, Tenn. Born, Chicago, Ill., Sept. 10, 1900. Parents, Merville Vincent and Mary Olive (Turnbull) Morton. Education, BSME, University of Illinois, 1923; MSME, University of Colorado, 1932; ME, University of Colorado, 1933. Married Lelia Teloir Hendren, 1923. Jun. ASME, 1924; Assoc. ASME, 1930; Mem. ASME, 1932. Served as Manager, 1943–1945, and as chairman of various sections; member of the Research Committee; and Honorary Chairman, student branches at University of Tennessee, and University of Colorado.

Wallace Langdon Newell (1867–1949)

WALLACE L. NEWELL, construction engineer at the Holden Copper Mine, Chelan, Wash., died in Seattle, Wash., on Feb. 1, 1949. Born, Pine Island, Minn., Nov. 8, 1867. Parents, Francis Smith and Sarah Langdon (Riddler) Newell. Education, Shell Lake (Wis.) High School, 1886; Wisconsin State Normal School. Married Lillian McIntosh, 1894; deceased 1897. They had no children. Mem. ASME, 1914.

Patrick A. Phelan (1879–1949)

PATRICK A. PHELAN, self-employed engineer, formerly with E. I. du Pont de Nemours and Co., Inc., Wilmington, Del., died in Lansdowne, Pa., March 24, 1949. Born, Ireland, Aug. 16, 1879. Parents, Nicholas and Catherine Phelan. Education, public and parochial schools of Philadelphia, Pa.; graduated from Drexel Institute of Technology, 1909. Mem. ASME, 1919. He was unmarried.

William Edward Rea (1905–1948)

WILLIAM EDWARD REA, chief engineer, Williams Brothers Corp., died in St. Louis, Mo., Nov. 23, 1948. Born, Valier, Ill., Dec. 7, 1905. Parents, William Harold and Roberta Rea. Education, Arkansas City (Kans.) High School, 1921. Married Dorothy Ann Klopfenstein, 1929. Mem. ASME, 1939. Survived by wife and daughter, Sue Jane, Casper, Wyo.; and his mother, Mrs. W. H. Rea, Benton, Ill.

Laurence Froyd Seaton (1887–1948)

LAURENCE FROYD SEATON, operating superintendent, The University of Nebraska, Lincoln, Neb., died in Lincoln, Neb., Jan. 2, 1948. Born, Seaton, Ill., March 26, 1887. Parents, John Henry and Ida Jane (Palmer) Seaton. Education, BS, University of Nebraska, 1911; ME, University of Nebraska, 1919. Married Pearl Erwin, 1913; children, Marjorie and Wanda. Mem. ASME, 1940. Survived by his wife and two daughters, Marjorie Cassity, Hamden, Conn., and Wanda Webster, Gastonia N. C.

William Gustavus Starkweather (1869–1949)

WILLIAM G. STARKWEATHER, president, Starkweather Engineering Co., Newtonville, Mass., died in Newtonville, Mass., on April 23, 1949. Born, Milwaukee, Wis., Sept. 13, 1869. Parents, William Henry and Mary Louise (Parsons) Starkweather. Education ME, Cornell University, 1892. Married Helen Kellogg Burr, 1895, who died Feb. 1, 1944. Mem. ASME, 1897. Served on the Meetings and Programs Committee, 1918–1922; Chairman, ASME, Boston Section, 1919. Survived by son, John Burr Starkweather, daughter, Mrs. R. P. Adair; and sister, Jessie Converse Starkweather; and six grandchildren.

Emil C. Stolberg (1875–1949)

EMIL C. STOLBERG, chief engineer of the American Car and Foundry Co., New York, N. Y., when he retired in 1945, died at his home in Glen Ridge, N. J., on May 4, 1949, after a long illness. Born, Belleville, Ill., April 5, 1875. Parents, George H. and Elizabeth Mary Stolberg. Education, BSME, Washington University of St. Louis (Mo.), 1896. Married Bertha Pauli, 1902, who died in 1937. Mem. ASME, 1917. Survived by two sons, Charles P., Cleveland, Ohio, and William G., Detroit, Mich., and a daughter, Helen S., Washington, D. C.; and three grandchildren.

Warren Grover Cleveland Thompson (1885–1949)

WARREN G. C. THOMPSON, associate professor, mechanical-engineering department, Pennsylvania State College, State College, Pa., died at the Center County Hospital, Bellefonte, Pa., on March 22, 1949. Born, Scarlett Mills, Pa., Feb. 4, 1885. Parents, Howard Boyer and Esther Sarah Thompson. Education, BS, Pennsylvania State College, 1908; ME, Pennsylvania State College, 1913. Married Amelia L. Hughes, 1919. Assoc. ASME, 1918; Mem. ASME, 1926. Survived by his wife and three daughters, Sarah T. Saylor, State College, Pa., Esther T. McGeehan, Dunmore, Pa., and Marie Claire Thompson, Woonsocket, R. I.

Samuel Kepner Varnes (1885–1949)

SAMUEL KEPNER VARNES, chief engineer, ammonia department, E. I. du Pont de Nemours and Co., Inc., Wilmington, Del., died in a Wilmington, Del., hospital on April 18, 1949. Born, East Salem, Pa., May 21, 1885. Parents, Joseph D. and Mary A. (Kepner) Varnes. Education, BSEE, Pennsylvania State College, 1906; ME, Pennsylvania State College, 1913. Married Florence Virginia Snyder, 1912; children, Clara Louise and Anna Barbara. Jun. ASME, 1910. Served on the Boiler Code, Main Committee, 1937–1947; Committee on Ferrous Materials, 1939; Chairman, Special Committee on Clad Vessels, 1937–1947; Subgroup on Austenitic Plates, Tubular Products, Castings, and Forgings, 1947; and Subgroup on Stress Allowances for Ferrous Materials.

William von Phul (1871–1949)

WILLIAM VON PHUL, former president of Ford, Bacon and Davis, Inc., New York, N. Y., died April 17, 1949, at his home in Larchmont, N. Y., after a short illness. Born New Orleans, La., July 20, 1871. Parents, William and Mary McDougall (Williams) von Phul. Education, BS, Tulane University, 1891; ME, Tulane University, 1893. Married Marie Alzire Cade, 1895. Honorary DE, Tulane University, 1931. Mem. ASME, 1907; Fellow ASME, 1941. Survived by his wife, a son, Captain William von Phul, Jr., U.S.N.R. (retired); four daughters, Mrs. Armin A. Uebelacker, New York, N. Y., Mrs. William Thompson Smith, Mrs. Rodney M. Ollinger, and Mrs. Charles G. Ollinger, Jr., Larchmont, N. Y.; and a brother, Nolan Stuart von Phul, San Antonio, Texas.